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THE INSURRECTION IN CUBA—A BATTLE IN A PALM FOREST.

THE INSURRECTION IN CUBA.

As we have had occasion before to remark, the struggle between Spain and the disaffected in Cuba has not the character of an ordinary war. There are neither armies nor pitched battles. As in all the revolutions in Central and South America, it is a hand-to-hand conflict and depends largely on the resources of the country and its natural advantages. Ambuscades, marches and counter-marches, which are prolonged almost indefinitely and in which numerous small bands of insurgents called *partidas*, commanded by leaders called *cabeceiras*, ravage the country, are sufficient to hold in check a whole corps of an army. These bands, composed of a hundred, often several hundred, men, are made up in large part of negroes or mulattoes equipped with arms of all kinds and wearing the large hats of the planters, operate principally in the eastern part of the island, in the provinces of Puerto Principe and Santiago de Cuba, where the heavily wooded and mountainous character of the country is specially adapted to the maneuvers and surprises of the guerrillas. Arms and horses are taken from the inhabitants. Fierce and insatiable, they utilize the least accident of ground, and skirmishing without relaxation, thus they torment the Spanish troops, cutting telegraph wires and destroying railroads. They also destroy the store houses, the coffee and tobacco plantations and the sugar works, which are situated in the center of the plantations.

The insurgents take advantage of all manner of positions, trees even, especially palm trees, become points of attack, and our present engraving shows insurgent troops firing on Spanish troops from palm trees.

The following, recently written by a Havana correspondent of the New York Sun, gives an interesting insight into the true situation of Cuban affairs relating to the present war:

Havana, August 7.

To those to whom the Cuban rebellion against the Spanish government is of any interest, and who, wishing to know the truth, trust entirely to the official news, or, on the other hand, give credit to stories of filibustering sympathizers, perhaps mistaken on account of verbal transmission, the conflicting nature of the news brings only uncertainty.

The difference exists that, while the rebels communicate exclusively through verbal messages, acting as an army on foreign territory, the Spanish government in possession of the wires, the post and the railroad lines, ruling with a powerful hand in the quiet cities of the island, exercising on the newspapers a strong censorship, omitting the reports from the interior that tell of the rebels' lawful treatment of prisoners, their organization and resources, their movements and victories, publishing a record of crime as the main deeds of the rebels, has in its hands all the material necessary to give out those made-up stories of the campaign that astonish the reader by the extraordinary phenomenon of an enemy always dispersed and torn to pieces, though gathered and hostile next morning; of a nation winning every military action, though still sending troops by the thousands to fight against the vanquished.

Since February a great many scattered encounters have occurred of no consequence whatever, though both parties proclaim them to be serious engagements, involving heavy losses to the other side and no harm to themselves; but apart from these slight skirmishes, in the four real battles fought, El Ramon, Jobito, Cacao, and Peralejo, victory has shone upon the single star banner. At El Ramon firing began early in the morning, lasted until 7 P. M., and eighty survivors of the Spanish forces were set free by the insurgents after giving up their arms and ammunition; the battlefield, a cemetery, helped the Cubans. At Jobito the troops were caught in a defile, losing 300 men, but aided by re-enforcements expressly sent for from the town, Commander Robles made a gallant retreat at 5 P. M.; Colonel Bosch, the surgeon, and several officers lost their lives there. The battle of Cacao has been told of lately, and at Peralejo, General Fidel Alonso Santosioides, his aides, seven officers, and over 120 men were killed on the Spanish side. The Cubans lost three officers and 100 men, but held the ground, and though the troops reached Bayamo at 9 P. M., they had no time to cut a wire fence that gave way under the pressure of the retreating men. Sixty pack mules laden with cartridges belonging to the Campos forces were accidentally seized by the rebels, and the retreat has been considered by intelligent observers a wonderful feat of skill and good luck for General Campos, who commanded in the action. In a letter to the Minister of War at Madrid he said: "Never did I see such a storm of lead; it was a perfect shower of bullets." But events like this must happen if the quality of the enemies is borne in mind.

On one side strong, healthy, and sturdy veterans of the past war, knowing every inch of the ground, and thus able to act separately, with no other burden than the native machete, carried since boyhood, and a rifle, fighting with the enthusiasm that the desire for freedom gives, against raw recruits, forced by discipline to go forward, without interest or passion, carrying, under the burning sun, to which they are unused, the load of their ammunition, bayonet, rifle, blanket, and knapsack, and obliged to follow the column or, if they get lost, to meet hunger and death. When ready for battle, 15,000 insurgents must face 52,000 Spaniards, and if all the lawful advantages of warfare were not taken, and the "guerrilla" system were abandoned, perhaps Spain would have an easy task; but, with the Cubans constantly harassing the troops, gathering in great numbers to strike a sure blow, scattering when the cannon sounds, firing heavily as soon as the troops form a square to resist a machete charge, the advantage is plainly on their side, and has to be a marked one, for the life of a Cuban is more to the "Insurrectos" than ten men to the troops, replenished every day by new arrivals from Spain. In short, so far, the native and the expeditionary armies are on equal terms, at least on land; at sea expeditions sail whenever they are ready, and land successfully.

When the Cuban rebellion broke out, Spain looked on with disdain, stigmatizing the movement as that of a lively party out for mere sport; but matters went on, General Calleja was recalled and blamed for not checking the war at the beginning, and, as the truth was

not to be told, he apologized, wishing Campos to straighten out everything. Spain had in Cuba 3,000 regulars; the rebels numbered as many in the western province. Spain had 80,000 volunteers that would not leave the cities for the battlefield, and, if forced to, would revolt. Now Spain has on the island her chief military genius, 30 generals and 52,000 regulars. Thirty thousand more are to come before October. Official news published in the papers a week ago spoke well of the sanitary statistics, as only ten per cent. of the troops were in the hospital, or 5,200 out of 52,000. Supposing yellow fever, malaria, diarrhoea, smallpox and other diseases to steal an average of 10 men from every division, it amounts to 100 per day, or 3,000 per month. But though the 52,000 did not come together, nor were all here in February, calling the death rate only 2,000 a month from April to October, when the new reinforcements are to arrive, 14,000 men of those coming will be no addition to the expeditionary army, but will merely cover the losses produced by sickness, and the whole number of 30,000 may be looked upon as substitutes, if the influence of lead and steel is taken under consideration. So we cannot possibly see how Spain is going to stop the rebellion before winter with the same standing army that has been steadily unsuccessful for nine months.

In 1874, 7,000 Cubans at most fought for independence, brought Spain to make a treaty of peace, and got nothing. In 1895 there are in the field already at least 15,000 Cubans, and there will be 25,000 by December next. The entire population of the island is convinced of Spain's poverty, of the uselessness of demanding from the government the political reforms, economic measures, and general benefits not granted in seventeen years. All this has changed the "Buenos Españoles" (good Spaniards), who in 1898 would have given their money and lives to preserve Cuban soil for Spain, into mere spectators of present events, fully conscious of the harm done to the industries and commerce of the island in behalf of those of Spain. Cuba will soon bring to an end the present war, and put an end to the last domination of the most miserable of European monarchies on any portion of land situated within the limits of America.

PROVIDENTIAL FUNCTIONS OF GOVERNMENT, IN RELATION TO NATURAL RESOURCES.

THE annual address before the Section of Economic Science, at the Springfield meeting of the A. A. A. S., August 29, 1895, by Professor B. E. Fernow, of Washington, D. C., was of marked interest. The following is the substance of what he said. He began by the suggestion that the name of the section be changed to that of Social Science. But, practically, we use the term economic science to include all political, commercial, and social life, as well as what is strictly economic. The discussions in this field are as yet progressing largely on a priori, instead of a posteriori reasoning. Men rely more on proposed working theories than on discovered laws. Hence economists are divided into hostile camps, differing in the most fundamental principles. Working theories may aid further development, even with differences of conception that lead to diversity of opinion, e. g., the dynamic and the fluid theories of electricity, and the undulatory and corpuscular theories of light. But such theories are the scaffolding, not the foundation. Broad, unalterable law rests on facts observed and that can be tested; and it is the organized and related condition of these facts and laws, their interdependence and structural aggregation which gives to science its name and character, although the building is not, and never is, to be finished. Have we sufficient foundation walls for social science, or have we mainly scaffolding, and but a few parts of foundations, not too firmly placed and lacking mutual support?

It will be partly my task on this occasion to point out the danger and impropriety of considering the social development of man as closely analogous to the biological development of plant and animal, an error of that school which has for several decades potentially influenced economic thought, and which is known as individualism, with Herbert Spencer as its most powerful exponent.

The revolution which the fascinating philosophy of Darwin has brought into the manner of explaining the development of the plant and animal world has asserted itself concerning man's life. We may easily agree that selection, rejection, competition and adaptation are also used by the human world in the struggle for existence so far as the simple biological growth of man is concerned. We may even admit that this was perhaps all in the earliest history of social development, when the race was just emerging from barbarism. But we shall fail if we are content to accept these same forces as the only ones now at work. The human individual differs from the brute in head and heart, reason and emotions, breeding, wisdom and character. These two factors, these additional variables, make our analysis of social development difficult. We do not deny their existence, as germs, in the animal, but in man they are possessed in an infinitely greater degree of perfection. To secure these two qualities two new aims were added to those that man has in common with the rest of the living creation. These aims enable him to interfere with the working of the natural laws of physical development, without reference to the struggle for existence, and even to modify and transform the very conditions that necessitated the struggle. They become the moving force of further social progress. They are bred and fed by associated effort. At first, perhaps, the same instinct was alone active in man that leads the ants and the bees to association; but as the reason and the emotions became developed, they became the directive forces both of individual and social effort, and stronger than mere biologic force. Not that thereby human development became "a bewildering exception to the reign of universal law;" for the reason and the morals also develop under laws, but the process grows more complex, a function of more variables, a result, not alone of physical but also of psychic forces and of rational deliberation.

Had the progress of man relied on biologic forces alone, he might never have exceeded the stage of the lowest savagery. Such writers as Joseph Le Conte

and Lester F. Ward, after careful analysis, affirm that in applying biology to sociology "humanity is distinguished from animality and reason from instinct," and that what is true of irrational animals may be altogether inapplicable to rational man. I am not prepared to deny altogether direction to the emotions, just as the force of gravity is both dynamic and directive; the intellect, however, has the supreme power of direction.

Whatever value then the other evolutionary biologic forces have had in the animal development of man, the tendency has been to undervalue the part played by the intellect and the affections in his social development in the progress of civilization. I would give the emotions the highest value in the past and assign to the intellect an increasing importance in the future direction of man. But we agree that thus far the emotions have had the largest share, and this fact has had due recognition from neither the individualists nor the socialists, which history develops at every step. The socialists would make co-operation compulsory, suppressing the individual as thoroughly as in a colony of ants. The individualists would let progress shape itself under a law of competition that suppresses the organization which has thus far served to develop the moral and intellectual forces, a method carrying us back to the brute world. It is certainly difficult to see that the individual will, independently of society, develop the social instinct, and desire the common good at the cost of his own good, and finally seek co-operation as the result of superior intelligence. How can free competition produce co-operation, which is its antithesis? "We are told," says Mr. Ward, "to let things alone, and to let nature take its course; but has intelligent man ever done this? Is not civilization itself, with all it has accomplished, the result of man's not letting things alone, of his not letting nature take its course?" In other words, civilization is the result of artful co-operation coerced rather than voluntary. Now we are asked to give up this great advantage laboriously gained, and to return as far as possible toward the beginning, and to experiment and see if the free individual, left alone, would not again develop co-operation, which, after all, is preferable to competition!

The whole upward struggle of man has been one of resistance to the law of competition, and now the individualists, ignoring this fact, and only observing that governments have often failed to perform their functions well, propose to curtail the functions instead of improving the methods. They would deliberately neglect the social in favor of the biologic forces. As chemists making universal soups by synthesis overlook the existence and claims of the palate and cater alone to the stomach; so the individualists deal with a map as a machine of physiological construction and moved by physiological forces, overlooking the interference of mind and heart, which make co-operation a necessity. It makes a great difference in an association like our own (the A. A. A. S.) whether we subscribe to the views of the laissez-faire school or to those of what we might term the faire-marcher school.

Between the individualist and the socialist stands the true democrat, in whose creed the "demos" rules with all liberty to the individual that does not interfere with the good of society. The goal of progressive civilization is the material comfort and the moral and mental development of all the members of human society present and future. And this is to be gained, not alone by negative or restrictive methods, but mainly by those that are positive and active, whether ameliorative or coercive, whenever society would suffer by non-interference with individual activity. The true democrat does not regard government as an evil and a thing outside himself, but as a good created by himself for attaining the highest human ideal both present and future. The functions of his government lie wherever the co-operation of the whole will accomplish the end aimed at by society better than it can be gained by individual effort, avoiding all needless interference.

"The end of government is the good of mankind" is less a formula, as Huxley calls it, than a historical fact in its briefest and broadest statement. Locke thus gave expression to the visible trend of the evolutionary development of society, and the humanitarian tendencies of modern governments, as compared with those of old, stand out boldly, in spite of many lingering clanish policies. Yet the practical statesman who succeeds for the portion of mankind segregated as a nation, may feel satisfied that he has done his part for the good of mankind. He seems to require such limitations. Antagonisms between governments will have finally to be smoothed away to make room for that ideal nation described by Huxley, "in which every man's moral faculty shall be such as leads him to control all those desires which run counter to the good of mankind, and to cherish only those which conduce to the welfare of society."

However poorly this end of government has been attained, and however sadly its functions have been perverted, the conception exists and diversity of opinion prevails as to methods only. The good of any particular nation is to be gained by activity rather than by inactivity, and by restricting that kind of individualism which leads a man to seek to have everything his own way regardless of the rights of others. The individual realizes the higher human ideal only when, as a citizen, a social being, a member of organized society, in community with others, he seeks national or even cosmopolitan activity for the good of all.

Social man, not by means alone of unconscious adaptation, but consciously, adapts himself to his surroundings, and more than that, adapts his surroundings to himself, and intentionally gives shape to the future. In this he differs from the animal world and has outgrown their laws of development. The momentum of education, with its gradually accumulated tendencies, drives him on in the path of social and ethical improvement, with the best ideals always before him. The sense of duty, which is the motive of altruistic actions, is nothing but this momentum that produces the conscious progress of the race toward new and better ideals. We observe the seeming paradox that feelings excited in the assembly lead the members to very different independent actions from what would have been done had each acted separately on his own motion. Patriotism, which is an individual virtue, can hardly even be thought of outside of organized associations.

The altruistic aspirations of the apostles of humanity, while benefiting individuals, are of a communistic nature, possible only in society and attainable only by associated effort. Government then becomes providential. It is the instrument of associated action, the brain and hand of the nation, the means of both social existence and social progress; and out of this arise its providential functions, as contrasted with its current functions concerning the more immediate social needs. It regards not only communal interests as against individual ones, but also future interests as against those of the mere present. It seeks the perpetual well being of society, and the perpetuity of those conditions that are favorable to the same.

We do not create this special providence for the individual, but for society; and each man will have to work out his own salvation with the advantages thus offered by society. But society can only act through the government, which, as the representative of the future, cannot, like the individual, "let the future take care of itself." In our present legislation there is little recognition of this providential character, even in the matter of education, whose aim it is to provide for the future. The questions of the franchise, and of immigration, are oftener discussed with regard to the rights of present members of society than the future good of society itself.

The one condition of social life that most affects the future, namely, the economy of resources, has received the least recognition, both in practice and in theory. The reason is that the need of its analysis has not yet been so pressing as it will become, now that the corners of the earth have been explored and the limit of our resources is becoming known, while the causes of depopulation are diminishing. The time is at hand when questions as to the extension of suffrage, of the tariff, of taxation, of coinage, etc., will seem to be mere incidents, and will sink into the background, while the question of the economy of resources on which depend the political, commercial and social power of the nation will claim supreme attention. For only those nations that do economize their resources and avoid needless waste can maintain their power and existence. Little harm can come from matters that can be easily readjusted; but whether fertile lands are changed into deserts, forests into waste places, brooks into torrents, rivers into agencies of destruction—these are questions that affect the very existence of society. And since such changes once made are often irreversible and the damage done irremediable, their consideration is of prime importance. As individuals the knowledge of the near exhaustion of our anthracite coal fields may not induce us to deny ourselves a single scuttle of coal so as to make the supply last longer; but we can conceive that, as members of society, we may refuse to let the miner or the consumer waste that supply.

Absurdly enough we have begun with an effort to prevent the exhaustion of our fish and game resources, instead of with more vital matters. This shows that emotion rather than reason is the prime mover. Love of sport has led us to protect our fish and our game, and also to improve our public roads by legal interference with individual greed and selfishness, just as in some countries they guard against the waste of wood and water. Resources may be classified as, (1) those that are inexhaustible; (2) exhaustible and non-restorable; (3) restorable, but liable to deterioration under increased activity; and (4) restorable and apt to yield increased returns to increased activity.

Land, water, air, and the forces of nature would fall under the first head, although their inexhaustibility with reference to human requirements is not entirely established. Of the second class may be mentioned the mines of coal, gold, silver, and other metals, oil fields, natural gas wells, and other resources that, when they have satisfied our wants, may be gone forever. Examples of the third class are the timber of the virgin forest, the water power of the streams, the game and fish, and to some degree the local climatic conditions, all of which are capable of restoration under human care, after having been deteriorated by uneconomic exploitation. The fourth class includes the products of human industry and skill, the accumulated wealth, and other things for which the people themselves labor.

Conservatism inclines us to presume that the interests of society are more likely to suffer than those of the individual; and that a mistake in curtailing private interests will be more easily corrected than one in disregarding social interests. Each special case will require its own consideration and adjudication. The general fact that the government is an instrument to secure both social life and progress, interests communal as well as personal, future as well as present, may give an idea as to how far its providential functions may be called into action.

The policy of governmental control should be extended to all exhaustible non-restorable resources. The ameliorative functions only are called into requisition concerning restorable resources. Whatever stimulates private activity is to be promoted, and whatever retards development should be removed. Industrial education, cultural surveys, bureaus of information, experiment stations, and similar aids constitute the chief methods of expressing state interest in private enterprises. The manufacturer increases the utility of things, but the farmer multiplies them; he is creative, and therefore has always claimed the right to prime consideration.

The state is certainly the original owner of the soil; but whether that ownership should continue is another question. The proper distribution and appropriation of the soil should belong to governmental control. One would think that the rational use of land for the farm, pasturage or tillage, could be left to private intelligence. Yet in fact the thin, rocky soils on mountain sides are often worked for a scanty agricultural return, when they should be left for timber, while thousands of acres in fertile valleys are still under the shade of virgin forests. A rational management of the water capital of the world is an economic problem of the highest importance. And in connection with this it is a matter of state interest to secure the conditions that will make a rational use of the water possible. Without forest management there can be no practicable water management, and consequently no stable basis for continued productive agriculture, industry and commerce.

I may be allowed to state more in detail the con-

siderations pertaining to the one resource with which I am most familiar. The virgin forest answers two purposes of civilized society. It gives directly desirable material, and it also forms a soil cover, which affects, directly and indirectly, the conditions of water flow, soil and climate. The individual takes the timber, the accumulated growth of centuries, thinking only of a profit on his own labor and outlay, without a thought of the relation of the forest to other conditions. Again he culls the forest, naturally taking the best cuts of the best timber, leaving the ground to the less useful kinds and to the weeds that occupy the space and that also prevent the reproduction of the more desirable kinds of trees. Thus the future of the forest resource is injured and its value deteriorated by changing its composition and quality.

When the marketable timber is gone, the interest of the individual in the forest dies. Conflagrations kill or damage not only the remaining old timber, but all the young growth of desirable trees, and often burn out the soil itself, which consists of mould from the decay of litter accumulated through centuries. Thus by leaving this resource wholly to the activity of individual interests, it is quickly exhausted, its restoration made difficult, and its function as a material resource is destroyed. It is possible to so exploit the forest that the reproduction of the best kinds is secured, but this entails curtailment of present revenue; and as the new crop takes decades to grow to maturity, the incentive to the individual is slight. Even the stability of family estates, which formerly stayed off the evil day, has at last yielded to the rapidity of modern changes.

The other function of the forest, its acting as a soil-cover preventing erosion, regulating water-flow, changing surface into subsoil drainage, and thereby influencing rivers and climatic conditions, renders it pre-eminently an object of governmental consideration. The attempt to get the largest profit from private labor tends to reckless management; hence the need of state interference. In some cases restriction may suffice; in others state ownership, or ownership by a permanent association, is necessary. It is to be hoped that this national association will see to it that this branch of political economy, the economy of natural resources, so important yet so neglected, shall receive a more full and thorough consideration than it has ever hitherto enjoyed.

THE SEVENTH SUMMER MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA.

By E. O. HOVEY.

THE Geological Society of America held its seventh summer meeting last week at Springfield, Mass., in connection with the American Association for the Advancement of Science. The members of the United States Geological Survey were conspicuous by their absence, all of them being engaged in field work at this time of year. The college men, however, were present in considerable force, and the meeting was a very interesting one, attracting many outsiders to its sessions. Nineteen papers were offered to the society, of which six were read by title in the absence of their authors. The topics treated in the papers read were pretty well scattered over the geological field, giving the devotees of each department something in their own line to consider and discuss.

In the rotation scheme adopted by the society, the glacialists had the floor first, and Prof. C. H. Hitchcock, of Hanover, N. H., opened the sessions with a discussion of the Champlain Glacial Epoch. He considers this period to have been a part of true glacial time instead of a part of post-glacial age. The elevated beaches along the Green and Adirondack Mountains show that there must have been a depression of from 1,200 to 1,500 feet, while extensive glaciers still existed considerably to the north and south, which discharged icebergs into the estuary formed by the depression. That this estuary was an arm of the sea is shown by the remains of marine life which are found in the terraces. Such forms occur as far to the westward as Lake Ontario. The life was decidedly arctic in character. Moraines and both marine and river clays cover till of an earlier ice sheet. It is possible to harmonize the conflicting theories of glacial and ice-berg action by referring the greater ice sheets to an earlier and the phenomena due to floating ice to a later Champlain epoch. In the discussion which followed the reading of this paper, the fact was brought forward by Prof. N. S. Shaler, of Cambridge, that two sets of terraces exist along the Mississippi River and its tributaries. One set is accordant with the plane of the rivers and is fluvial in origin; that is, the terraces were made by the river in question when flowing at a higher level. Another set occurs near the head waters of the rivers, which is discordant with the plane of the river and has not been satisfactorily explained.

The next paper was by Prof. H. L. Fairchild, of Rochester, and was entitled "The Glacial Genesee Lakes." It was a continuation of papers presented at recent previous meetings of the society on the Finger Lakes of central New York. The direction, inclination and extent of the Genesee Valley made possible the production, during the retreat of the ice sheet, of a succession of glacial lakes with different outlets. The northern boundary of these lakes was always the front of the receding glacier, and their extent varied as the recession of the ice freed lower outlets for the waters. These lakes all discharged to the south or west until the ice front reached Lake Ontario, and ten stages have been noted, favoring at different times the Allegheny, Susquehanna, Tonawanda and present St. Lawrence drainage. The Genesee Valley is almost entirely of pre-glacial age, and in only four places has there been rock cutting since the departure of the ice. These are at Genesee, Portage, Mount Morris and Rochester.

Prof. B. K. Emerson, of Amherst, Mass., gave an hour's most interesting lecture on the "Geology of Old Hampshire County in Massachusetts," which included a large part of the western portion of the State and much intricate geology. He divided his theme into three parts or chapters and dealt first with the crystalline rocks on each side of the Connecticut River, Triassic sandstones and traps. The rocks on the eastern side form one mountain mass, while on the western side they rise gradually, but with much complexity, until at some distance from the river the axis of the

Green Mountains is reached. There are three pretty well defined areas of Archean rocks. Much of the region is occupied by Cambrian white gneisses and also by amphibolites and other schistose rocks. There has been much folding on both sides of the Trias, and many anticlines and synclines may be seen. In some places the rock is still under so great tension that the force is made use of in quarrying operations. A series of drill holes is made in the desired direction and then let alone. In the course of several hours, sometimes over night, the rock splits with a loud noise along the lines determined by the drill holes. Some of these cracks have been more than seventy feet long. The Chester Emery Mines are in a hornblende gneiss of the region.

The second chapter of the lecture was on the Triassic estuary indicated by the red sandstones of the valley. By means of maps Prof. Emerson showed his method of theoretically reconstructing the valley. The great trap ridges known as Mount Holyoke and Mount Tom form the most striking features of the scenery of this part of the valley. The ridge is of volcanic origin and was poured out on the bottom of the great Triassic estuary under a great depth of water. The ridge for fifteen miles shows both on top and underneath a mixture formed by the rolling and kneading together of trap, limestone and sandstone when the sheet was poured out. Aside from these great overflow ridges, Prof. Emerson has located a series of the cores or plugs that were left in the throats of the old volcanoes when they became extinct. The series occupies the line of an old fissure, just as small parasitic cones occur in lines on the flanks of Mount Etna and other volcanoes at the present day.

The third part of the paper dealt with the surface geology and described graphically the present status of the region, the meanders of the Connecticut River through its fertile valley and the location of three ancient glacial lakes. The latter were the Springfield Lake, bounded on the north by Mounts Holyoke and Tom. This lake became filled with gravel and sand. The Hadley Lake, north of those mountains, was an "unfilled lake," and the present surface level is nearer that of the river than in the case of the Springfield area. The third lake was in the vicinity of Amherst. The draining of these lakes must have been sudden, almost catastrophic. On Wednesday afternoon the genial professor led a large party of the members of the society over a portion of the area and gave ocular demonstration of many of his points.

The paper by Mr. Arthur Hollick, of Columbia College, was the next one taken up. He gave the results of studying some plant remains from Martha's Vineyard, and enumerated the species which prove the strata to be of Cretaceous age.

"On the Eocene Fauna of the Middle Atlantic Slope," by Prof. W. B. Clark, of Johns Hopkins University. This paper described the occurrence of fossil remains from central Delaware to the northern boundary of North Carolina. Preceding authors have reported not more than twenty-five forms of life. By special means of collecting and preservation of the fossils of great delicacy, Prof. Clark has increased this number to one hundred and twenty-five, and he thinks that the area is of more general significance and wider importance than most geologists have admitted. The presence of so much greensand and clay in the strata shows that they were of slow formation, while the beds of Tertiary age in the Mississippi Valley and vicinity were of very rapid growth. While there cannot be a sharp delimitation into sub-divisions in the middle Atlantic beds, the group is held to be representative of the larger portion of the Gulf section.

Paleontology was continued in the next paper, which was on the "Arrangement and Development of Plates in the Melonitida," by Dr. R. T. Jackson and T. A. Jagger, of Harvard University. Melonites is a genus of carboniferous echinoderms which has never before been correctly understood. The authors' work shows that the development of this genus is away from the simple type and that it can no longer be considered an intermediate form between recent and Paleozoic echinoids. Both came from some other more generalized form.

"Pre-Cambrian Volcanoes in Southern Wisconsin" was the title of a paper by Prof. W. H. Hobbs, of Madison, Wisconsin, in which was described a series of interesting lavas which occur in the valley of Fox River, near Portage, Wisconsin. Some of the localities exhibit superb examples of spherulite, perlitic, flowage and brecciated structure, but the original glassy ground mass of the rocks has become devitrified—that is, secondarily crystalline.

Following this came another petrographic paper, by Prof. A. C. Gill, of Cornell College, entitled "A Geological Sketch of the Sierra Tlayacac, in the State of Morelos, Mexico."

The Sierra Tlayacac, situated to the southward of the great fault line described by Felix and Lenk, consists of a projecting group of mountain tops in the midst of the Morelos plain. The plain is formed by the lava streams and ejectamenta of Popocatepetl or neighboring volcanic vents. The tops of the nearly submerged mountains show that the folding and elevation of the Cretaceous (Caprina?) limestone was accompanied or followed by the deposition of a limestone conglomerate, in the pebbles of which are also Caprina (?) fossils. Lack of eruptive pebbles indicates that the volcanic activity of the region was subsequent to extensive folding and erosion.

The limestone conglomerate is overlain by an acid eruptive, and both rocks are cut by numerous dikes which show a close "cousanguinity" with the recent extrusions of Popocatepetl. The very striking metamorphism produced by these dikes corroborates the view that there is little, if any, migration of material from the intruded mass into the metamorphosed rock.

Heated water and steam would appear to be the principal agents of metamorphism, rather than heat alone, since the great distance to which recrystallization has reached seems dependent on the porous character of the rock before alteration.

Garnet, vesuvianite, wollastonite, and pyroxene are among the minerals developed, and large crystals have been found at a distance of several hundred feet from the contact.

The metamorphosed limestone herein described is a beautiful rock, well shown by numerous samples in the American Museum of Natural History in this city.

Prof. J. F. Kemp, of Columbia College, then gave an account of the titaniferous ores of the Adirondack Mountains. The merchantable magnetites of the region are in gneisses, while those carrying the metal titanium are in the gabbros and anorthosites of the Norian series, which are believed to have been intruded through the gneisses. A distinction was made between the smaller ore bodies, which are apparently basic segregations in gabbro, and the enormous ore bodies at the old Adirondack Iron Works in the heart of the mountains, which are in a massive rock almost entirely formed of large blue-black crystals of labradorite feldspar. The wall rocks show no signs of the widespread crushing that is exhibited in the general "mortar structure" of the Adirondack and Canadian anorthosites, but are plutonic rocks free from evidences of dynamic metamorphism. The argument is then made that the ores are segregations from an igneous magma and formed during the process of cooling and crystallization.

"The Decomposition of Rocks in Brazil" was the topic discussed by Prof. J. C. Branner, of the Leland Stanford, Jr., University. The disintegration and decomposition of rocks is much more rapid and profound in a tropical than in a temperate climate. This has been demonstrated in Brazil by railway cuts and tunnels and by deep mines. There has been no glaciation in the country and the decayed rock remains in situ, as the United States engineers who went down there to build the first railways found out to their sorrow and cost. Innumerable landslides of the decayed rock took place during the rainy season in tunnels and cuts which were not protected by heavy masonry. Tunnels from one part of Rio de Janeiro to another show disintegrated rock to a depth of at least one hundred feet from the surface. In one of the great mines in the province of Minas Geraes the mining down to the depth of 375 feet had all been done by the pick. The daily and yearly changes of temperature in Brazil are not as great as in most parts of the United States, but they are sufficient to produce slight cracks which admit water, air and insects, and these set up a train of reactions that soon destroy the rock. The chemical destructive agents at work are organic and inorganic. The latter are carbonic and nitric acids brought down by the rains in great quantities. The organic agents are insects and plants. The ground is filled with vast hordes of ants whose breath and food form acids which attack the rocks and the rapid decay of a very rank vegetation is an active agent of destruction.

Prof. W. M. Davis, of Harvard, detailed to the society the "Bearing of Physiography on Uniformitarianism." We cannot call upon nothing to do something—this is the fundamental idea of uniformitarianism rather than that the present forces have always acted with their present value and rate. Physiography can well embrace all the features of the earth in their relation to man, but a knowledge of geology is necessary to understand the existing forms of land and water. When the present features are looked upon as the results of long acting forces, the study of physiography is as much enlivened as were zoology and botany by the promulgation of the theory of evolution. Prof. Davis gave a graphic illustration of his subject by tracing the process of adjustment of river valleys which is going on, selecting the Marne and Aoult rivers of France as furnishing a typical, uncomplicated example.

"The Analysis of Folds," by Prof. C. R. Van Hise, of Madison, Wis., was a masterly treatment of an exceedingly difficult subject. He showed that rock folds occur in nature as compound flexures in three dimensions instead of simple flexures in two dimensions. Each great fold has a series of secondary folds on it transversely, and there may be still other series in addition.

The president of the society, Prof. N. S. Shaler, of Harvard, had the last place on the programme with an address "On the Effects of the Expansion of Gases from the Interior of the Earth." Wherever gases are generated in a liquid or semi-liquid mass, the fact of such generation diminishes the pressure over a given bubble. A "chimney" is thus developed up which a series of bubbles may rush, as may be seen in a glass of carbonated water.

There is much water in rocks and much more in soft strata. Mud lump springs along river bottoms and particularly along the Mississippi are due to discharges impelled by the liberation of gases. Outbreaks of gas follow earthquake shocks. Hundreds of blow holes or "shock fountains" were formed along the Ashley River after the great Charleston earthquake, ten years ago. They were from ten inches to three feet in diameter. The liberated gas was found to have come from a stratum about 50 feet below the surface. Very large and strong shock fountains were formed along the Mississippi River during the earthquakes of 1811 and 1813. These were a hundred feet in diameter and threw mud to a height of 200 feet. A volcanic eruption works on the same principle.

Eleven new fellows were elected to the society: S. B. Baldwin, of Cleveland, Ohio; Dr. O. C. Farrington, Field Columbian Museum, Chicago; Prof. G. P. Grimsley, Washburn College, Topeka, Kansas; F. P. Gulliver, Norwich, Conn.; Prof. J. B. Hatcher, Princeton, N. J.; Dr. E. B. Mathews, Johns Hopkins University, Baltimore; Dr. J. C. Merriam, Berkeley, Cal.; H. B. C. Nitze, Baltimore; F. S. Ransome, Berkeley, Cal.; Charles Schuchert, United States National Museum, Washington; J. A. Taff, United States Geological Survey, Washington.

PROPOSED BALLOON VOYAGE TO THE POLE.

DURING the last century many expeditions to the North Pole have been undertaken, but with no result so far as reaching it is concerned. Baron Nordenfjeld, the great Arctic explorer, has made four expeditions to Spitzbergen, and two to Nova Zembla and Greenland, besides having taken part in the celebrated voyage of the Vega. In all explorations both he and others have found the icebergs the chief obstacle; and it may be said that Arctic explorers are now almost all unanimously convinced that the pole can never be reached in steamer or sledge. Attempts on foot have likewise failed, for the distance of about ten miles has

never been exceeded, owing to the great difficulties and dangers.

Notwithstanding these facts, Dr. Nansen, the celebrated Norwegian explorer, attempted yet another way, and instead of cutting a path through the ice, he has allowed himself to be carried poleward by a northerly current. This took place a year and eight months ago, and he has not been heard of since.

Quite recently, at the Royal Academy of Science, Stockholm, an even more perilous project was proposed by M. Andrée, a Swedish engineer. M. Andrée proposes making the expedition in a balloon. The project is not a new one, but it has never been seriously discussed by Arctic explorers. M. Andrée, however, has had much experience in polar regions, having spent the winter of 1882-83 in the far north, and also taken part in the Swedish Meteorological Expedition, which lasted a year. He has also proved himself to be a dauntless aeronaut, his most interesting voyage being one from Gothenburg to the Isle of Gotland, in which he had to cross part of the Baltic. Everything in connection with this proposed expedition has been minutely studied and discussed; and infinite pains have been taken to solve all difficulties.

The balloon would require a double outer covering, and a volume of 6,500 cubic yards. The ascensional power thus obtained would be sufficiently great to carry three persons, furnished with provisions for four months, besides allowing for the car being fitted up with necessary instruments for observation, life buoys, and Berton's collapsible boats. The car could be suspended in such a way as to allow of instant detachment in case of a descent into the sea. The entire weight of the balloon must not exceed about three tons. In the instance of Henri Giffard's captive balloon, exhibited in 1875, and which weighed about six tons, it only required newly inflating after a year's use. According to Graham's observations, a balloon measuring 8½ yards in diameter can be made sufficiently airtight so as to suffer, per month, merely a loss of 13½ pounds of its ascensional force. M. Andrée, however, hopes to produce an absolutely impermeable covering.

The balloon being protected from the wind by a wooden inclosure, would be inflated as far north as possible, by means of hydrogen compressed in cylinders. This once accomplished, it would begin to ascend. To a certain extent it might be steered by means of a sail and several guide ropes, which dragging on the earth, form as it were a brake. The ropes, however, would have to be of special composition, in order to produce the same effect in water. The hindrance thus caused to the flight of the balloon, together with the pressure of the wind, would allow the use of a sail. The flight then might reach an angle of 40° away from the wind direction. This steering apparatus, invented by M. Andrée, has often been used by him in his aerial voyages.

Spitzbergen has been chosen as the starting point, for this island is almost always clear of ice by the middle of June. The departure would take place in July, on a clear day, with a southerly wind. At Spitzbergen the average rate of wind per second is 10½ yards; the guide ropes would cause a hindrance of about 2½ yards per second; therefore the average rate of balloon would be nearly 8 yards per second, which is about 16 miles an hour. At this rate the pole should be reached in 43 hours.

The summer is in all respects the most suitable time for an aeronautic voyage in Spitzbergen. The lowest temperature observed at Cape Thorsden in July, 1883, was +0.8° C. and the highest +11.6° C. The movements of the balloon would therefore be very regular. Besides this, there are practically no storms, and the fall of snow in June and July is both slight and rare.

M. Andrée's project has been highly approved of by the most experienced Arctic explorers. Baron Nordenfjeld has declared himself in favor of it, and M. Eikholt, chief of the Swedish Meteorological Expedition to Spitzbergen in 1882-1883, states that the conditions of the Arctic regions are most favorable for this voyage. He thinks, moreover, that in the future the balloon will be the principal means of exploring that part of the world.

For many of the above details we are indebted to an article in the *Revue Scientifique*, by M. Charles Rabot.—Nature.

DIGESTION IN PLANTS.*

By J. PRENTLAND-SMITH, M.A., B.Sc.

THE term digestion implies those processes by which food material is rendered available for the nourishment of the organism. We shall confine our attention in this paper to a consideration of some of the more remarkable cases of plant digestion.

The nutrient matter partaken of by the higher animals, such as man, undergoes various complex changes before it can be taken into the circulation, and definite changes occur in definite regions of the alimentary canal. To begin with, the food is masticated in the mouth, where it is at the same time bathed in a secretion poured forth by the salivary glands. Not only does this fluid enable it to pass more easily down the oesophagus or gullet into the stomach, but it digests certain of its constituents. The saliva contains a substance of complex composition, probably closely related to a class of chemical compounds termed proteids. One of the essential distinctions of proteids is that they consist of carbon, hydrogen, oxygen, nitrogen, and sulphur, united in percentage proportions somewhat as follows: Oxygen, 20.9; hydrogen, 6.9; nitrogen, 15.2; carbon, 51.5; sulphur, 0.3. Many of them are constituents of food, and we shall have to speak presently of the changes they undergo preparatory to absorption. The proteid-like substance in the saliva, to which we now refer, is called ptyalin. Owing to its action the starchy portions of the food are converted into sugar. The curious feature is that the ptyalin itself remains unchanged. There are numerous examples of analogous actions in the domain of chemistry, and they play an important part in plant nutrition.

A substance like ptyalin, capable of causing chemical changes in other bodies while it itself remains unchanged, is called a ferment or enzyme.

When the food reaches the stomach, it is subjected to the action of a fluid secreted by special cells lining

its cavity. Some of these secrete an acid—hydrochloric acid—and others secrete a ferment called pepsin. The latter is only produced after the absorption of nitrogenous matter by the cells; its function is the conversion of insoluble proteids into soluble compounds termed peptones.

It may happen that all the food material has not been rendered available for the animal's nourishment by the time it leaves the stomach. We find that there is a provision made to meet this contingency, for into the commencement of the intestine fluids are poured, which are secreted by the liver and pancreas. The bile, secreted by the liver, contains a ferment that converts starch into sugar, and the pancreatic juice contains three ferments: trypsin, which converts proteids into peptones—the action of pepsin—but which possesses the additional property of carrying the decomposition a stage further, breaking up the peptones into "nitrogenous crystalline bodies, chiefly amides, such as leucin and tyrosin;" steapsin, which emulsifies fats, and then splits them up into glycerine and fatty acids; and amyllopsin, by whose action starch is converted into sugar.

Now, it will be our endeavor to show that all these ferments have their representatives in the plant kingdom, and to show what uses they subserve there.

In the annexed figure (Fig. 1) we have a section of the maize fruit, cut so as to show the connection of the nourishing matter, or endosperm, with the embryo plant. The endosperm is markedly divisible into two portions; that to the left, shaded darkly, consists of cells filled with nitrogenous material, the cells of the lighter shaded part adjoining the embryo being densely filled with starch. Starch is insoluble in water, and so cannot diffuse through the cell walls. It is found that during the formation of the endosperm a ferment is formed whose function appears to be the conversion of starch into a substance that can easily pass through the cell walls, and so be directly available as food for the growing embryo. This ferment has received the name of diastase. It converts

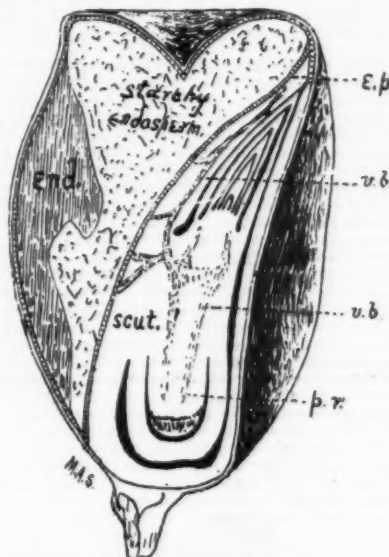


FIG. 1.—Longitudinal Section of Maize (*Zea mays*) Fruit. end., yellow dense portion of endosperm; ep., epidermis of scutellum; v.b., vascular bundles; p.r., primary root.

starch into sugar. But diastase is not confined to the seeds of certain plants. It is of very common occurrence in the vegetable world. Indeed, one observer has asserted that it is present in all living plant cells. We may take as an instance the potato tuber and show its use there. During summer the chlorophyll-bearing cells of the potato plant manufacture a large quantity of sugar, much more than is required for its own growth. The superfluous sugar is carried down to the underground stem, and is there stored in the form of the non-diffusible starch in portions of the stem, which in consequence become much swollen, forming the potato tubers. These remain dormant during winter, but burst into vitality the following spring. Each eye, which is in reality a bud, shoots out into a stem bearing leaves, even although the tuber be kept in a dark cellar, and one observes that at the same time the tuber decreases in size and ultimately becomes quite shriveled up. The development of the stem thus takes place at the expense of the tuber; it is accompanied by complex chemical changes, one of which is the conversion of the starch in the tuber into sugar by the agency of the diastase stored up there. The sugar thus formed helps to build up the protoplasm of the growing aerial stem.

Numerous other instances might be cited of the presence of this ferment in plant cells. In fact, its common occurrence has led to the classification of ferments having a similar action as diastatic ferments. It is obvious that the ptyalin of the saliva is one of these.

The action of diastase upon starch can be demonstrated in the following manner. The diastase is extracted from the seed by means of water and glycerine, and poured into a "solution" of starch. After a longer or shorter period—depending upon the temperature—the starch is seen to be converted into sugar. If its action be examined in situ, it is noticeable that the grains are gradually dissolved in a uniform manner.

It has recently been shown by Brown and Morris that in addition to the diastase, whose almost universal presence in living plant cells we have just noted, there exists in the seeds of certain grasses another form of diastase, to which they have given the name of "secretion diastase" to distinguish it from the former, called by them "translocation diastase." Referring to Fig. 1, we see that a portion of the stem below the first leaf (cotyledon) is very large and shield-shaped. On this account it has received the name of scutellum.

* From Knowledge.

In its outer layer of cells, or epithelium, adjoining the endosperm, the secretion diastase is manufactured, and it is poured forth into the neighboring endosperm cells, where its presence can be detected by its remarkable action upon the starch grains. It converts these into sugar, but their dissolution does not proceed uniformly; instead, the grains assume a markedly pitted appearance, and ultimately dissolve. This diastase also differs from translocation diastase in the time of its appearance. It is only formed when the grain commences to germinate. Its function thus appears to be the conversion of starch into sugar for the benefit of the germinating plant. If the actively growing embryo (Fig. 2, A) be placed on starch paste, with the scutellum resting on the paste, the starch grains will display marks of corrosion, due to contact of the secretion diastase secreted by its epithelium.

Yet another digestive action occurs in the endosperm of grasses, according to Brown and Morris. Previous to the dissolution of their starchy contents the cellulose cell walls near the scutellum become soft and ultimately disorganized. This is accompanied with the appearance of starch in the epithelial secreting cells. The diffusible substance formed from the cellulose is not known. Probably it is sugar, which, passing into these cells, becomes stored up as starch. The ferment causing this action has been isolated; it is a proteid substance, and is secreted by the epithelial cells of the scutellum. These cells thus secrete two ferments, one to dissolve the cell walls of the endosperm, and another to dissolve the starch grains thus exposed.

There are certain seeds in which the endosperm is composed mainly of cellulose. This is markedly the case in the date palm (*Phoenix dactylifera*). Every one is familiar with the extremely hard nature of the date "stone." This stone is the seed of the date. A transverse section of it is shown in Fig. 2, B. The embryo occupies only a small portion of the seed; the remainder is filled with endosperm which has taken the form of cellulose. An examination of the seed at short period after the commencement of germination shows a somewhat different state of affairs. The main part of the embryo lives outside the seed coat; the endosperm has decreased in amount, and a part of the cotyledon is closely applied to it. As the embryo increases in size, the endosperm gradually decreases, until it finally disappears. From the relative positions of the parts it is obvious that it must have been absorbed by the young plant, and the only way to account for the corrosive action of delicate cells on so hard a material is the assumption that these cells secrete a ferment, and that this dissolves the cellulose, as in the barley grain. Search for such a substance in the date palm has, however, hitherto been in vain.

Prof. Marshall Ward, in an elaborate paper in the "Annals of Botany," shows that he succeeded in isolating a cellulose-dissolving ferment from a fungus called "batrytis," that sometimes causes havoc among lily plants, giving rise to what is known as the lily disease. The threads (hyphae) of this fungus eat their way into the interior of the living cells of the host plant. From their tips a brilliant, refringent, viscid fluid is secreted. Marshall Ward cultivated the fungus in Pasteur's solution—a nourishing fluid containing the constituents of fungus food in a readily available form—and so procured a large number of the fungal hyphae. On squeezing these in water he obtained a large quantity of a fluid containing the ferment in solution, for, when it was applied to thin sections of the lily stem, the cellulose walls were observed to swell up and become gradually dissolved.

Starch and cellulose are composed of carbon, hydrogen, and oxygen, the latter two being present in the same proportion as in water, viz., one to eight by weight. Such substances are termed carbohydrates.

Hitherto we have considered only the digestion of these bodies; we shall now direct our attention to enzymes, by whose action complex nitrogenous compounds are rendered directly suitable for plant food.

sectivorous plants, the use subserved by its digestive property is quite obvious from a consideration of its habitat. It lives in marshy places, where there is small store of nitrogenous food.

The species of *Drosera* (*Drosera dihotoma*) is not a British fern, but it illustrates the main features of the British species. Insects retained by the viscid fluid secreted by the leaves soon undergo decomposition. The nitrogenous parts of the body are digested—the hard outer skeleton alone is left—and the products of digestion are absorbed by the leaves. After stimulation by the absorption of nitrogenous matter, the secreted fluid contains a ferment and an acid. The ferment in presence of the acid attacks proteids and converts them into peptones. The stomach, we previously noted, contains an acid, and a ferment called

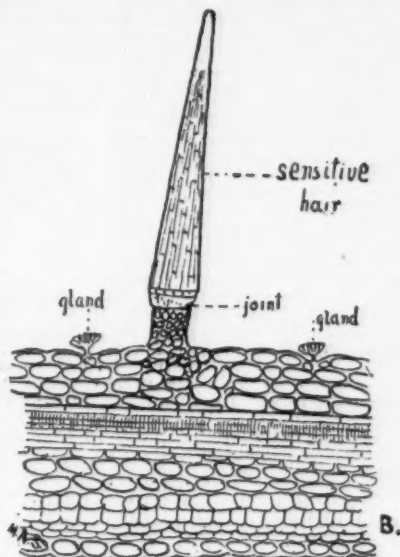


FIG. 3.—B. Transverse section of leaf-blade of *Dionaea muscipula*. Notice the jointed sensitive hair and the digestive glands.

pepsin, which has the same property as that of *Drosera*. Pepsin also is only secreted after the absorption of nitrogenous matter by the walls of the stomach. In these respects, then, it appears that the digestion occurring on the tentacles of *Drosera* is similar to that taking place in our stomachs. It would appear that the ferment of *Drosera* is the same as, or, at least, closely allied to, the pepsin found there.

The leaves of *Pinguicula vulgaris* (the butterwort), another common British insectivorous plant, displays a like action to that of *Drosera*. Insects captured by the sticky secretion on the upper surface of the leaf are rolled toward the center by the incurving margin, which secretes a peptic fluid.

On each lobe of the leaf of *Venus' Fly Trap* (*Dionaea muscipula*) are three long jointed hairs, extremely sensitive to contact of a solid body. An insect alighting thereon and touching one of the hairs instantly finds itself a prisoner, as the lobes immediately close up and clasp tightly the unwilling guest. Glands on the upper surface of the leaf secrete an acid fluid, into which a ferment is poured after the absorption of nitrogenous food. The result is that the captured insect is soon digested, with the exception of the hard cuticular skeleton. The glands are shown in section in Fig. 3, B. They consist of a rosette of cells supported on a very short stalk, bringing them slightly above the level of the other epidermal cells. The section also illustrates the jointed nature of the long hairs. The presence of the joint enables the hair to bend down, and thus prevents it breaking when the lobes become approximated.

The arrangements for the capture and retention of insects with a view to digestion are very elaborate in the *Nepenthes* or pitcher plant. The winged portion of the leaf (the petiole or leaf stalk), the tendril, the outer surface of the pitcher, and the under surface of the lid are covered with nectar-secreting glands. Especially numerous are these on the under surface of the winged petiole. They allure insects to the orifice of the pitcher. The rim is corrugated, and each corrugation corresponds to a bottle-shaped nectar gland, whose orifice faces the bottom of the pitcher. The upper part of the inner surface is so very smooth that an insect is unable to obtain a foothold thereon; the lower part is partly filled with a watery liquid, into which is poured a digestive fluid by peptic glands lining that portion of the inner surface. The upper smooth part has been termed the conducting surface. In the sketch given herewith (Fig. 4, A) is depicted a small portion of it. The lenticular excrescences were considered by the late Professor Dickson to be modified stomata. Professor Macfarlane has lately verified this supposition by finding every transition between these and perfectly formed stomata. What happens is this: One of the stomatic guard cells rises above the level of the epidermis in such a manner as to cover the other guard cell and the stoma from the view of the observer. The function of these modified stomata is unknown, but it is conjectured that they secrete the greater part of the liquid found in the cavity of the pitcher. In support of this it is to be noted that the pitcher lid is at first closely applied to the rim of the pitcher; by and by it gradually opens, and never again shuts up. But in unopened pitchers a considerable quantity of liquid is to be found, and Macfarlane states that in species of *Nepenthes* with a large conducting area, large quantities of liquid are exuded. In any case the liquid, containing an acid and a ferment, acts in a manner quite similar to the digestive action of *Drosera*, with the result that in the pitcher insects may be found in all stages of decomposition. This decaying mass must act as an attraction to insects in the native haunts of the *Nepenthes*, causing them to fly straight into the cavity of the pitcher.

Macfarlane gives an interesting account* of observations made by him on the visits of insects to the *Nepenthes* in the conservatories of the Royal Botanic Gardens, Edinburgh: "Being in (one of the conservatories) at 8:30 P. M. on a clear evening in June, a large cockroach was noticed to be perched on the front part of the corrugated collar of a fine pitcher of *N. khasiana*. Approaching cautiously, it was seen to bend its head into the pitcher cavity and sweep it rapidly in successive jerks round the inner edge of the corrugated collar, where the products of the marginal glands would lie. Sipping the material from these, it then rested for a moment, and enjoyed with evident relish the cleaning of what adhered to its mandibles. It then repeatedly tried with its fore legs to step on to the conducting surface of the pitcher cavity, but always slipped; so, leaving this, it reared itself on its long hind legs by planting one on each side of the rim, catching with the middle legs on to the lower sides of the lid. Placing its fore legs on the middle of the lid, it swept with its mouth parts the richly honeyed surface in long lines. But this did not appear to be satisfying, when compared with the product of the marginal glands, for it speedily returned to these and renewed its jerking mode of feeding. It again attempted to get into the pitcher cavity, but, finding this unsafe, it finally licked up traces of the marginal gland secretion, which its fore feet had smeared on the corrugated collar. Running down the outside of the pitcher, it passed up the tendril and on to the under laminar surface, where its presence would have been perfectly unsuspected had any insectivorous birds been in the neighborhood, and where, also, as Mr. Symington Grieve has suggested, it would have been sheltered from the sun's heat in the daytime. I gently scratched the upper surface above where it was, and it at once retraced its steps in a hurried manner, till it reached the outer surface of the pitcher. Here it rested for a time sipping the juice which exuded from alluring glands, but it soon passed to its old position on the collar. Though disturbed a few minutes before, it seemed quite to forget its fright, and again fell to cleaning the marginal gland orifices with the utmost care and gusto. It rested now and again only to resume operations, once making a short excursion to the lid surface, which appeared to me to offer far greater attraction, but, seemingly regarding this as inferior, it returned to the collar. Constantly trying to get on to the conducting surface, and as often foiled, it again ran up along the tendril to the under surface of the lamina. Again I scratched this, and the former course was taken, the former efforts made. I was greatly struck by the careful way in which, while attempting to pass into the pitcher, it hooked its two strong hind legs over the reflexed collar margin, and by the ability it showed to pull itself back by these alone, the second as well as the first pair of legs often being inside the pitcher. Tired of its movements after the fifth excursion, and finding that twilight was approaching, I finally jerked it into the cavity with my pencil as it hung on the ridge exploring the interior. In its fall it quickly spread out its long legs against the sides of the conducting surface, and struggled violently to get out. For a short time this proved useless—it rather slipped deeper; but, after one severe effort, it hooked the claws of its fore legs over the corrugated rim, and pulled itself out. I considered that it had fairly earned liberty, and it speedily moved off."

This observation confirmed the supposition of the great attractive nature of the marginal glands of the corrugated rim. Observations on the visits of ants afforded further confirmation. These insects are allured by the glands on the stem and leaf to the margin of the pitcher, proceeding by way of the under surface of the winged petiole, on whose ridge are numerous nectar-secreting glands. The wings also shield them from the rays of the sun and from the observation of foes. Having reached the pitcher rim, they strive to obtain nectar from the orifices of the marginal glands, and in their eagerness they over-reach themselves and fall into the cavity of the pitcher, from which escape is practically impossible.

In connection with the visits of ants to *Nepenthes* an extremely interesting circumstance has been noted which seems to throw some light on the doctrine of acquired characters—a point of dispute among biologists. *Nepenthes bicalcarata* is infested by a particular species of ant. On the tendril opposite the bottom of the pitcher is a small swelling. In specimens obtained from its native habitat a round hole has, as a rule, been drilled in the swollen portion; but in those grown in our conservatories, although the swelling is always

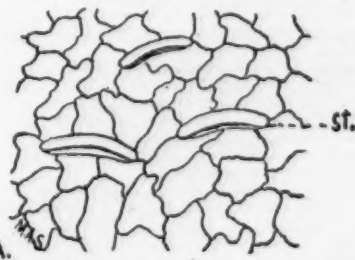


FIG. 4.—A. Portion of epidermis from conducting surface of pitcher of *Nepenthes*. Notice the lenticular excrescences (st.) These are modified stomata.

present, it is never punctured. The suggestion has been made that the ants, finding it impossible to obtain the liquid contents of the pitcher in the ordinary way without fatal issue to themselves, have resorted to this method from an instinctive knowledge of the fact that water will rise to its own level, for when the swelling is punctured the liquid in the pitcher oozes from cell to cell until it reaches the aperture. The extra supply of liquid thus brought to this region of the tendril causes an excessive growth of the tissues at this point. Owing to the visits of these ants, this hypertrophy has occurred in the majority of individuals of the species for numberless successive generations, and has so affected the constitution of the plant that now

* "Annals of Botany," vol. vii, p. 426.

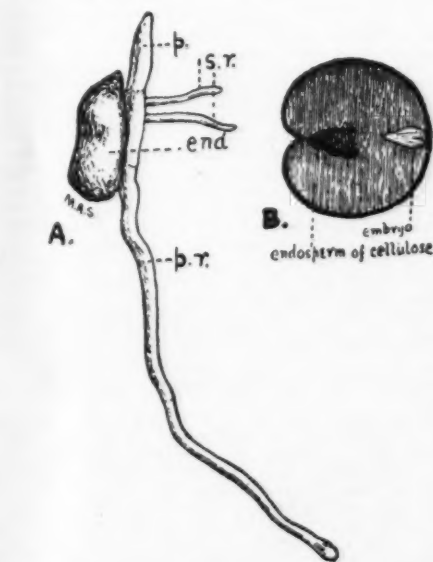


FIG. 2.—A. Germinating embryo of Maize, detached from endosperm; end., scutellum; s.r., secondary roots; p., primary stem; p.r., primary root. B. Transverse section of Date seed ("stone").

The most remarkable, or, at least, the most interesting, examples are found among the so-called insectivorous plants.

The pretty little sundew (*Drosera rotundifolia*), consisting of a small root and rosette of reddish-green leaves, nestling in tufts of sphagnum moss, displays a markedly digestive action, causing it to resemble the animal stomach in many respects. Its method of capturing and retaining its insect prey was explained in a previous paper in Knowledge. In it, as in other in-

the swelling always appears, although the original inducing cause be absent.

The Australian pitcher plant (*Cephalotus follicularis*) is only found in the moorlands of Albany, in Western Australia. Two kind of leaves are found on the plant. The laminae of the lower rosette of leaves are transformed into pitchers to entrap unwary insects. The pitchers are rendered attractive by their bright color, and their outer surface is provided with nectar-secreting glands. As the pitchers rest on the ground, wingless insects are thus allured into their cavities. Once inside, escape is almost impossible, as a consideration of the structure of the interior of a pitcher will render evident. On the inner edge of the involute margin is a fringe of decurved spines, and every cell of the epidermis below is projected into a sharp downward directed hair. The rim of the deep circular involution is likewise armed. Then the basal portion of the pitcher is filled with a liquid, into which are exuded an acid and a ferment by glands situated on that portion of the epidermis.

The trypsin secreted by the pancreas has its analogue in the plant kingdom in a ferment found in a tropical plant called the Papan (*Carica papaya*). Green states that the natives of India have for long used the fruit of this plant for cooking with tough meat to make it tender, and that there is a prevalent notion that wrapping its leaves around it, or even hanging it under the tree, has a similar effect! Certain it is that a ferment—papain—has been isolated from the fruits, which has the power of digesting various proteid substances.

The power of the walls of the true stomach of the sucking calf—rennet—to coagulate milk by the secretion of a ferment is familiar to all; but some plants have a similar property. The common bedstraw (*Galium verum*) is even now used by West of England dairymen for this purpose, and in the days of Linnaeus the Laplanders put the leaves of *Pinguicula vulgaris* (the butterwort) to the same use. Both plants contain a milk-curdling ferment, which has also been found in the stem, leaves and seeds of various other plants.

In *Ricinus communis* (the castor oil plant) the endosperm is oily. If a glycerine extract of the germinating seed be mixed with an emulsion of castor oil, and kept at a temperature of 40° C., the liquid becomes acid, and after some days glycerine makes its appearance. If the extract be boiled before it is added to the oil, these changes do not occur. They are the result of the action of a ferment present in the endosperm of the germinating seed. This ferment is thus similar in its action to the steapsin of the pancreas.

STARS AND MOLECULES.*

ONE of the most remarkable features in the recent progress of astronomy is the way in which it has shown that the greatest and the smallest things in nature are not at the two extremities of a long-continued upward slope, but are mingled in the closest intimacy. Astronomy illustrates the phenomena of electricity in a comet, of heat in the sun, of light in a star or a planet, of gaseous radiation in a nebula, upon a scale which is immensely great, by means of the violent encounters or collisions, or (in plain English) by the knocks of most minute atoms and molecules.

In astronomy we have to do with the greatest things in nature. The sun is ninety millions of miles distant from the earth, and of a bulk one and one-third million times as great. The planet Neptune is thirty times as far away as the sun. The nearest to us, so far as we know, of all the stars (α Centauri) is well nigh ten thousand times as distant as the planet Neptune; while beyond it are hundreds of millions of stars further and yet further off. Some that can be just detected are probably ten thousand times as remote as α Centauri, or, in other words, three thousand million times as far away as the earth is from the sun.

But the light that comes across those distances, and reveals those far-away orbs, reaches us through movements and vibrations due to molecules far smaller than any microscope can reveal. That light shakes the minute molecules of a photographic plate placed in the focus of a telescope, and leaves behind the record of its knocks. It vibrates in the bright lines of solar and stellar spectra. In a no less wonderful way molecular knocks—most minute, but most numerous—transmit and maintain the heat of the sun and of the stars.

But it may be asked: What are molecules and atoms? Can we affirm their existence? Can we measure their size or detect their action? Can we count them, or determine the number and energy of their knocks, if they are so minute?

An atom literally means that which cannot be cut. According to the atomic theory of the constitution of matter, all bodies are supposed to be made up of atoms. An atom, therefore, represents the smallest possible quantity of any elementary body, a quantity incapable of subdivision, if indeed such a conception of indivisibility is possible.†

A molecule literally means a little mass, and is considered to be an aggregation of a certain number of atoms; in general of atoms of different elements, but in some cases, it may be, of atoms of a like kind. Molecules are held to form the ultimate constituent particles of a compound body. The molecules of such a body cannot be divided if it is to retain its nature as a compound. They will, however, be resolved into constituent atoms, if the compound body be resolved, by some process or other, into its constituent elements. So long, for instance, as water is water, its molecules each consist of two atoms of hydrogen joined to one of oxygen. But, if a volume of water be resolved, by heat or electricity, into two separate volumes of oxygen and hydrogen, each molecule of the water is thereby resolved into its constituent atoms. All the atoms of oxygen go together to make up the total volume of oxygen, and all those of hydro-

gen to form the total volume of hydrogen, obtained from the given volume of water. So also in other similar cases.

There must be a certain maximum limit of size for the molecules in any compound body and for the atoms which compose them. If we could take a drop of water and divide it into two equal parts, and repeat the process with each half, again and again, a time would come when we should at last be forced to divide a molecule, and break it up into its atoms. Those atoms would be oxygen or hydrogen, but they would no longer be water. Sooner or later, according to what the size of a molecule may be, this would occur, otherwise water would not be the compound that it is.

The hypothesis that all bodies are made up of ultimate atoms, and that, in each compound body, a certain regular number of the atoms of its components are combined into molecules, is accepted, because it explains so many of the simpler and of the most complicated phenomena of chemistry and of other kindred sciences. Nevertheless, molecules or atoms are believed to be of a diameter from two hundred and fifty to five hundred times too small for the most powerful microscope to reveal them.

To attempt to measure, in any way, the size of particles so minute might almost seem to be hopeless. The measurement has nevertheless been made, not perhaps very accurately, but with a remarkable amount of success, compared with the difficulty of the problem. For instance, a soap bubble has been formed in which the film was proved to have a thickness of less than one two-millionth of an inch. Pure water would not have held together to form such a bubble. But the admixture of a small proportion of soap gave it the requisite tenacity. Hence it was concluded that, in any little cube of water, measuring less than one two-millionth of an inch in the length of its side, there was at least one molecule of soap occupying only a small part of that little volume. How minute, therefore, a molecule of soap must be! It has, in fact, been calculated that, in such a case, it would be less than one twelve-millionth of an inch in diameter.

If, however, further experiments are performed, determining the tension overcome and the heat produced in expending such a bubble (which tension and heat depend upon the number of molecules in the thickness of its film), a diameter is indicated for the molecules of water decidedly, but not greatly, less than one hundred-millionth of an inch. This very minute, although finite, divisibility of matter has been in some degree confirmed by the sense of taste, or color, or smell, in cases of extreme dilution; and very decisively by the spectroscopic analysis of the light of a flame, when there has been a quantity of sodium or of other substances vaporized in it so small that it would take several million times as much to weigh a single grain.

It has also been shown by Lord Kelvin that a certain amount of electrical action, involving the generation of heat, occurs when zinc and copper are brought into contact, which heat would be greater the more numerous the atoms in any given quantity of the metals. And, from the observed amount of heat produced when zinc and copper are used to form that alloy which we term brass, he has concluded* that the constituent atoms of copper or zinc cannot be much, if at all, less than one hundred and fifty millionth of an inch in diameter, but that they may be considerably larger. This gives an approximation to a minimum value for the size of an atom.

Careful calculations as to the effect of the molecules of a prism, in dispersing into a lengthened spectrum the variously colored component undulations of a ray of white light passed through it, further confirm the above statements.

It may be assumed from these, as well as from other lines of investigation, that the diameter of the ultimate molecules or atoms of bodies very probably lies somewhere between one twenty-five millionth of an inch and one two billion five hundred millionth of an inch. They cannot well be much larger or much smaller. And if it be said that there is a considerable difference between these two sizes, the answer is that it matters little whether we can state a certain limit, or one a hundred times smaller, in comparison with the achievement of having determined such limits at all. The actual range of possible size, just stated, is almost as nothing compared with that which might have seemed to be probable.

But there remains still to be mentioned one more instance of molecular action which has been investigated with even greater fullness. It is one which is intimately connected with recent astronomy, and one which brings us into the closest relation to those knocks of which we have already made mention.

It is the kinetic, i. e. the movement, theory of gases, involving the distinction between the solid, liquid and gaseous states of matter. In the solid state of matter, the atoms or molecules cannot be moved about among one another without the expenditure of considerable force to overcome the cohesion which holds them together. In the liquid state, while they still resist being torn apart, they are so far in a less restrained condition that they can be easily moved round one another. In the gaseous state they are quite free from cohesion, and are believed to be flying about in all directions with immense velocity, constantly knocking against each other, or against any surface within which a gas is contained.

Upon this supposition all the phenomena of gases can be explained. Heat expands a gas in making the molecules move more violently. Pressure heats a gas by affording additional energy to them. Expansion cools a gas when the molecules use up their energy in expanding it. A gas presses upon any containing surface by means of the knocks of its molecules. If a skin filled with gas be placed under the cover of an air pump, and the surrounding air be exhausted, then the gas within the skin will swell it out. Why so? Because of the energy of the knocks of the molecules of the gas inside. Those molecules are constantly flying about and hitting the inner surface of the skin, but their knocks are not now counterbalanced (as they were before the air pump was worked) by the knocks of the air molecules outside. Once more, if a gas be compressed, then (apart from any alteration in its temperature) it is found that every time the space

occupied by it is halved its pressure upon the containing surface is doubled. Why so? Because the same number of molecules are in one-half of the previous space, and therefore their knocks upon any part of the bounding surface are twice as frequent as before.

All this confirms the theory of the incessant movement of the molecules of gases; while those molecules must be within the limits of size already stated. But it may next be asked: At what speed or speeds do their movements take place within the volume of any mass of gas? Can their velocities be determined? Yes! So far as regards their average speed in any given gas. That average speed must be such as will enable the molecules of a given volume of gas to produce by their knocks the pressure actually experienced by the surface which contains the gas. It is also possible by observing the rate at which two volumes of gas, allowed to intermingle, are diffused into one another, to determine how far the molecules of any given gas move between their successive knocks against each other. We cannot describe such investigations more fully here. Let it suffice to say that they indicate that the molecules or atoms of each individual gas have their own special average rate of motion. To those of hydrogen, for example, which, owing to its light density, move with especial rapidity, a speed is assigned of about six thousand feet per second, or seventy miles per minute, at the zero temperature of the Centigrade thermometer—a velocity about six times as great as the average speed of a cannon ball. These gaseous molecules are so numerous that the most careful mathematical and physical calculations indicate that, under ordinary temperature and pressure, every molecule of hydrogen undergoes about eighteen thousand millions of knocks from other molecules in every successive second.

In the earth's atmosphere, the molecules of oxygen, one of its two principal components, move, upon an average, with about one-fourth of the speed of those of hydrogen, and inflict proportionally fewer knocks upon one another. Those of nitrogen, which forms its other chief component, move with a speed a little greater than those of oxygen. In the vapor of water the speed is about one-third greater than in oxygen.

We assume, then, that all gases are composed of atoms or molecules, of which there are millions of millions of millions in a cubic inch. These myriads of mites are ever flying about with intense velocities. Each knocks against, or encounters, its fellows, it may be five thousand millions of times, it may be twenty thousand millions of times, in a second. By the energy of these knocks heat is evolved, or pressure produced upon any surface which bounds or restrains the gas.

But what have these knocks to do with astronomy? We shall presently show their relation to the maintenance of the sun's temperature. There is, however, another interesting question connected with them, which we will now mention. It has been asked: May not the great velocities of these molecules in the gases which form a planet's atmosphere enable them to run away from any such planet, so that either the whole of its atmosphere, or certain constituent gases belonging to it, may thus be gradually lost? The answer must depend upon the power of attraction of the planet, at a given distance from its center, as compared with the velocity of any molecule there situated. If a particle were placed at rest at a certain distance from an attracting globe, it would begin to move toward the globe, with constantly increasing speed, until it should reach its surface. On reaching the globe its velocity would depend partly upon the mass of the attracting body. That velocity would also be greater the further off the point from which it started. But, however far away that point might be, mathematical calculations prove that the velocity, when the particle should reach the surface of the globe, could never exceed a certain limit of value. In the case of the sun, the earth, Mars and the moon, those limiting velocities would be respectively about three hundred and eighty-two miles; seven miles; three and one-sixth miles, and rather less than one and one-half miles per second.

Apart from any resistance of a surrounding atmosphere, it follows that a particle projected vertically upward (i. e., in the reverse direction) from any of the above named surfaces, with a speed exceeding that just stated as corresponding to the globe in question, would go on and on, gradually moving more and more slowly, but never coming to a stop. It would run right away and never return.

The average velocity of the molecules, even of hydrogen (in the cold outer regions of the earth's atmosphere), being only about one mile per second, and those of oxygen and nitrogen and vapor of water from one-fourth to one-third of that value, it would at first sight seem as if there were no chance that the molecules of any one of these gases could thus decamp from the earth, since it can control a runaway velocity of nearly seven miles per second. But it must be remembered that the velocities just stated are only average ones. Some of the molecules would at any time be moving much faster than others. They would all be constantly altering their speeds by mutual interchanges of velocity through the medium of their knocks.

It is probable that, at any ordinary temperature, some molecules of every gas would be moving at any moment with sufficient speed to run away from the atmosphere of any body, however great its attraction might be. But the permanence of the atmosphere of such a body would be practically secured if the proportion that might thus escape should be excessively small. And investigations in thermodynamics indicate that no knocks of molecule against molecule, no succession of interchanges of velocity between one and another of the molecules in oxygen or nitrogen or vapor of water, would enable those gases to escape, either from the earth or from Mars, through one molecule after another decamping in the course of ages. But it appears that all hydrogen may have thus departed from the earth, and a fortiori, from Mars. The hypothesis also suggests that no atmosphere at all could be retained by the hundreds of little minor planets, whose power of control is very much less.

In the case of the moon it seems that the whole of an atmosphere of a composition similar to that of the earth might have been lost in this way. But it is, perhaps, more probable that the moon may never

* From the Nineteenth Century.

† Last year, in his Inaugural address to the British Association, Lord Salisbury remarked: "What the atom of each element is, whether it is a movement, or a thing, or a vortex, or a point having inertia; whether there is any limit to its divisibility, and, if so, how that limit is imposed . . . all these questions remain surrounded by a darkness as profound as ever."

have had any appreciable atmosphere at all, owing to the earth (through its proximity and its greater attractive power) having taken into its own atmosphere any gaseous molecules from surrounding space which might otherwise have gone to the moon. There are also other ways in which the present non-existence of any appreciable atmosphere upon the moon or of any free hydrogen in the earth's atmosphere may be accounted for.

We consider that the hypothesis to which we have thus referred is interesting, but that it needs further discussion. As regards, however, its application to Mars, there are probable indications of the presence of the vapor of water upon that planet, whether it be there because its molecules are unable to run away or for other reasons. Those indications have been given by the spectroscope,* or by telescopic views of the apparent formation of clouds (such as seemed to obscure a region as large as Europe for several days last October), as well as by other effects which may be due to aqueous vapor. At any rate, we may say that the molecular knocks, of which we have been speaking, do not militate against the habitability of Mars, so far as that habitability may depend upon the existence of the vapor of water in its atmosphere.

We may, however, remark in passing that there are many reasons in favor of the supposition that Mars is more likely to have been inhabited in past ages than at the present time, in spite of its atmosphere, or water, or clouds. Mr. Proctor, for instance, has pointed out that a globe of the size of Mars would cool rather more than two and a half times as quickly as one of the size of the earth. If the earth and Mars were in a similar condition eighteen millions of years ago, Mars would have attained (according to that rate of cooling) to the earth's present condition in seven million years, i. e., eleven million years ago; and the earth would now require twenty-eight million future years in which to cool as much as Mars has cooled during the last eleven million years. So far as regards that consideration, therefore, the probability of the present habitability of Mars must be compared with the probability of the earth's being inhabited when twenty-eight million more years shall be past and gone.†

Let us next consider some greater astronomical knocks, to which we will pass on by an illustration connected with those which we have already discussed. We will suppose a small sphere of gas, perhaps an inch or two in diameter, in which the gas has been reduced by a Sprengel air pump, or otherwise, to the most extreme rarefaction attainable. Its density would then be much less than one millionth of the ordinary density of air (as in some of Mr. Crookes' experiments with the radiometer), while the number of gaseous molecules in it would be exceedingly reduced. These molecules would, however, still fly about with great velocities, but their free paths from one successive mutual knock to another would be greatly lengthened. Their knocks would at the same time be far less frequent, inasmuch as the molecules might only be a few hundreds of millions in number.

Now let us imagine this globe of gas to be allowed to expand in vacuum space until it should attain to a diameter of millions of millions of miles. If the molecules could then be much increased in size and also become of various sizes and very bright, the result might represent so much of the stellar universe as the utmost telescopic power reveals; for it is a universe in which every star is hurrying onward, like these molecules, with its own proper motion; a motion which is, however, dwarfed in many cases almost to apparent rest by the remoteness of the stars from us. The stars are all alive with movement, ever changing their positions, their mutual relationship and influence, their configuration, their attraction upon each other. This fact vastly increases our interest in these glorious orbs. Each at the same time may have its train of attendant planets. The past and future of our own sun and its planets may have depended, and may yet depend, upon the sun's onward travel. Our health, our life, our warmth and cold, may be determined by the locality which the sun may reach in his unceasing journey of about half a million of miles per day.

These onward movements of the stars are of no small account. The telescope only shows to us that portion of any such motion which is athwart, or at right angles to, our line of sight as we look at a star. But in fifty thousand years to come, which is only as a moment compared with the millions of years which astronomy and geology call upon us to contemplate, those partial movements would abolish the belt of Orion and bring Sirius to be directly under one of Orion's feet, instead of far away to the east, while Procyon would be nearer to Orion than Sirius now is. Fifty thousand years ago the seven chief stars of the Great Bear, instead of forming a plow or wain, appeared from this cause as an elongated cross. At the same time it should be remembered that the spectroscopic also shows the existence in the stars of additional movements, upon an equal scale, directly toward or from us.

And besides all the myriads of bright stars thus seen in telescope or spectroscope, there are probably many which have so far cooled as to be invisible. In certain cases (as, for instance, in the periodic occultation of the greater part of the light of Algol) we have decisive evidence of the existence of huge dark bodies, which, for aught that we know, may be very numerous, but which, by their cooling, would not in anywise have lost their onward velocities through space.

If so, it is only natural to ask whether knocks may not occasionally occur between some of these brighter or darker orbs. Possibly. But such knocks would certainly be very rare. However vigorously two bodies might draw each other together by their mutual attraction, they could not finally knock unless they had almost exactly the same velocity, or almost no velocity, in the direction perpendicular to that of the line of their mutual approach. Otherwise their near approach could only result in their whirling once past each other in sharply curved paths (their outer parts possibly grazing), just as a comet hurries round the sun. Or it might result in their revolving round

one another, as the components of a double star revolve, in elliptic orbits.

But we cannot deny that more or less direct knocks might, from time to time, take place. And the occurrence of so-called new or temporary stars, which involve a tremendous and sudden development of light and heat, may indicate that something of the kind has occasionally happened, and been seen by us. We refer to observations of 'outbursts of stellar light' such as Tycho Brahe saw in A. D. 1572, or Kepler in 1604; or to those more recently seen in the new stars of 1848, 1866, 1876, 1885; and in the very remarkable Nova, or new star, in Auriga in 1892. In such cases there may possibly have been some terrific knock or series of knocks.

If so, it must, however, be allowed that it is very difficult to account for the very rapid falling away of the light after its first outburst. The direct knock of two dark masses might certainly produce a wondrous brightness, invisible before, as the result of the conversion of the energy of their movements into heat and light. But it would not seem probable that the light of the united mass, thus rendered so brilliantly luminous, would fall in about a couple of months, as that of the new star of 1892 fell, from the fourth to the fifteenth magnitude, which means a one hundred thousandfold diminution of light; or that the star of Tycho Brahe could diminish its light a thousandfold, as it did, in little more than a year.

In 1892 it was thought that two brilliant bodies indicated their presence in the new star by a double spectrum, and that the displacement of the lines in the spectra, which were considered to be of two distinct classes, indicated that both bodies were in exceedingly rapid motion. If so, they might have so disturbed one another, even without actual contact, as to have produced very important eruptive effects. The spectroscopic observations have, however, received other interpretations. There may, perhaps, have been only a near approach of some dark orb to a bright sun, and a less rapidity of movement.

In any case, the explanation of the observations of all new stars, including that of 1892, is undoubtedly difficult. Whatever the truth may be, even if in most cases no actual knock of two great globes has occurred, such outbursts of light, owing to the violence of the disturbance produced, must almost inevitably involve a considerable number of what may be termed greater knocks. But all the phenomena exhibited would also ultimately depend upon countless molecular knocks in the light and heat evolved.

If, however, in especially rare instances (of which, perhaps, that of Tycho Brahe's surpassingly bright star of 1572 may be one), it be allowed that an actual knock of two huge bodies, meeting more or less directly, may have taken place, such an event would be very suggestive. It would carry us in thought to an epoch in the evolution of the solar system earlier than the nebular epoch imagined by Laplace (and recently illustrated by Dr. Roberts' photograph of the nebula in Andromeda), when that system may have been a vast nebula from which the planets and the sun were subsequently cast off or condensed. It would suggest that such a nebula may have originated in the terrific knock of two great globes, the joint mass of the two being about equal to that of the sun.

We think it possible that the light evolved in such a case might be comparatively transient (as with temporary stars), if the knock were strong enough to vaporize the whole of the two masses. Certain solid portions, while still unvolatilized, might give forth a great light, but only for a short time, by their incandescence, like the particles of carbon in the flame of a gas or candle. But subsequently the highly heated gas resulting, when the whole was vaporized, would not necessarily be very luminous; just as the very hot flame of a Bunsen gas burner gives out little light. When, however, the greater part of the nebula should contract into a central sun, it might become much brighter again.

The great compression of its mass as it contracted would conduce to an increase of its luminosity; and it is a very interesting fact that such a gaseous mass, by the very act of contraction, would necessarily for a long time increase its own temperature, even though that contraction should all the while result from the radiation of heat from its outer surface. Mr. J. Homer Lane, of Washington, some years ago showed that a globular mass of gas contracting by the radiation of its heat to one-half of its original diameter would double its temperature. Otherwise the eightfold increase of pressure outward, due to the compression in volume, would only be one-half great enough to resist a sixteenfold increase of the inward pressure. We say sixteenfold because the inward pressure would be increased fourfold by the increased gravitating attraction inward due to the lessened distance of the surface from the center of the sphere, and fourfold more (i. e., sixteenfold altogether) by the smaller surface over which that attraction would be spread.

Consequently it can be shown in the case of such a body as our own sun that, at the same time that it contracts through becoming cooler in any region where the density remains the same, it may become hotter where the density is increased through that contraction. It may rise in temperature at a given depth below its surface so as to radiate more heat to the earth, while the process of cooling from its outer surface continues.

Such an increase of effective temperature in a contracting globe is really due to the attraction of the mass of the globe upon the millions of millions of minute molecules in its gases. The sun is doubtless in the main a great globe of gas, although so intensely compressed in its central parts that they may be in a thickened or semi-viscous condition. The gravitating attraction of the sun's mass is ever tending to generate a downward velocity in the gaseous molecules, located in any part of it, toward its center. At the same time, the radiation of heat at its surface diminishes the upward counterbalancing pressure. This allows the molecules to be actually more or less drawn inward. Their individual average velocities are, upon the whole, increased. Their knocks against each other become more violent, and generate an increase of temperature. And the result, previously stated, which might at first seem to be almost paradoxical, is explained, viz., that the sun, as its surface radiates heat

away (which so far is a cooling process), may nevertheless, through its consequent contraction, generate a higher temperature by the fiercer clashing together, or knocks, of its molecules, as they are drawn inward. This may enable it to send forth a more intense heat and light than before.

Therefore we said just now that a gaseous nebula formed by one of the greater knocks of astronomy—the terrific knock of two great globes—after first showing a certain temporary brilliancy, and then, perhaps, becoming only faintly luminous while in a highly heated gaseous condition, might, in its subsequent slow contraction into a central sun, manifest a great increase of light and warmth. This result of an increased vigor in the knocks of the gaseous molecules would, however, only follow so long as they should retain their freedom to fly about and knock against each other. If such a globe of gas should begin to solidify, it would then enter upon a stage of very much slower contraction, and its supply of heat-radiation, due to the increased velocity of its molecules, would soon practically fail.

As regards the sun, it is believed that the heat evolved by such contraction as may be taking place in it at the present time keeps it very nearly at a constant temperature, and is just about enough to counterbalance its loss of heat by radiation. It has, however, been calculated that such evolution of heat by contraction cannot, in all probability, maintain the sun's temperature sufficiently to support life as at present upon the earth for much more than ten millions of years to come; nor that a similar supply can have been kept up for a period variously calculated at from ten to eighteen millions of years past. In any case, however, it is very interesting that the maintenance of the sun's temperature depends upon the knocks of its molecules, as affected by its radiation and gravitation, during the present existence in it of a condition chiefly gaseous. Apart from these knocks, the earth would almost immediately become a frozen lifeless waste.

Of other astronomical knocks we must say but little. They doubtless abound in the head of a comet, between the meteorites which in all probability form it, or in other groups of meteorites which may be coursing through space or revolving around suns. They may from time to time occur in the case of some of the myriad satellites which form the rings of Saturn. They may give some help to the evolution of gas, or of electricity, in comet, nebula, or star. But in regard to most of the phenomena observed in all these denizens of space, and especially in connection with those of the heads and tails of comets, in the glowing splendors and fiery jets of the heads, and in the immensely rapid repulsion of the tails, we believe that the molecular knocks are by far the most important.

The knocks and vibrations of electrical action, or of light and heat radiation, are, in consequence of their numbers and their vigor, of far more moment, in spite of the minuteness of the atoms and molecules involved, than any greater knock of one meteorite against another. These lesser knocks, which evoke, in an all-pervading ether, the undulations or vibrations by which the effects of light and heat and electricity are transmitted through space to affect our eyes, our brains, and our nerves, depend upon entities which are almost indescribably minute. Yet in astronomical observations they reveal to us the most brilliant luminaries, the greatest distances, the intensest temperatures, yet known.

In that branch of astronomy which depends upon spectrum analysis there is, however, something even more wondrous. When one far-distant body after another tells us by its spectrum of what gases or substances it is made; when comet, or nebula, or star reveals its own bright or dark lines, isolated in certain special localities in the spectrum, which localities are invariably the same for each gas or vapor to which they belong, and exactly correspond to the greater or less rapidity of the vibrations involved; why does each gas, in thus revealing its presence, produce only its own appropriate lines and rates of vibration, and no others? We cannot certainly say. It may be because the atoms or molecules of each gas, although almost indescribably minute, are capable of certain special individual vibrations of their own, and thereby impose certain vibrations, and no others, upon the ether within which they move. They may do so by their internal movements, or in some other way. Perhaps by the effect of their shapes as they move, or by a certain electrical action. Whatever the actual process may be, recent investigations indicate that the vibrations produced in the ether often form a beautiful harmonic series.

In any case, these molecular effects thus seen in the glittering lines of the spectrum of sun or nebula, of comet or meteorite, take us one step further into the mysterious recesses of the exceedingly small. These most minute actions of the very smallest things of which we know tell us of the constitution of the vastest, the most distant, the most glorious.

Astronomy may well claim to be the most wonderful of all sciences, not because its measures are upon a scale that seems immense to beings such as ourselves, but because, in its revelations, the very greatest and the very smallest things—distances measured by billions of miles, masses weighing quadrillions and quintillions of tons, light and heat far surpassing all that is earthly—are intermingled in intimate union with the vibrations and movements of molecules or atoms of which trillions may be found in a single cubic inch of gas. Our view of every sun, the explanation of its heat maintenance, the knowledge of its constitution, the knock of meteorite against meteorite, or even of star against star—all these in their vastness inextricably involve the knocks of molecules so small that it is difficult to believe that such minuteness can be real.

E. LEDGER.

* See the observations of Dr. Huggins, *Astrophysical Journal*, March, 1895, p. 308.

† Proctor's *Old and New Astronomy*, p. 542.

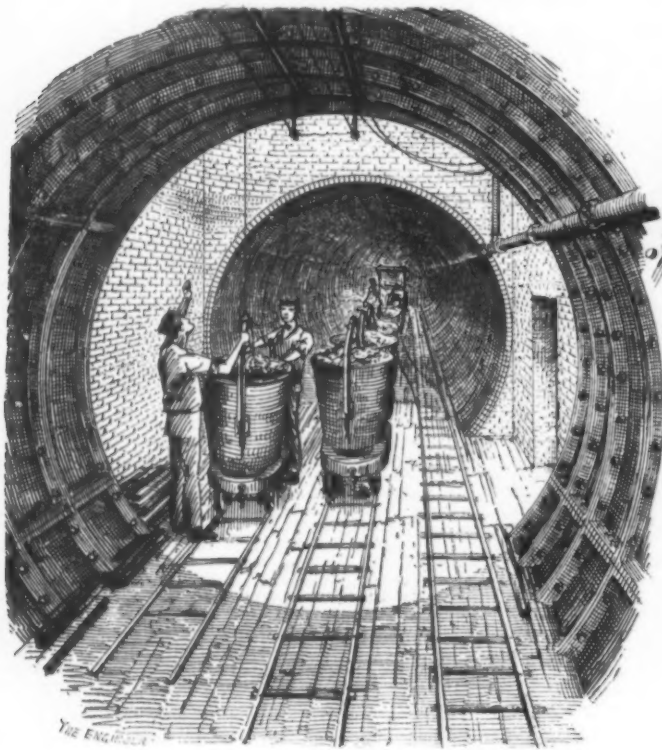
[FROM THE ENGINEER, LONDON.]
THE WATERLOO AND CITY ELECTRICAL UNDERGROUND RAILWAY, LONDON.

THE pressing need for a means of rapid communication between Waterloo Station and the City has been admitted for years. The extension of the Southeastern Railway to Cannon Street, the construction of the Metropolitan, which has enabled passengers arriving at Paddington, St. Pancras, or King's Cross to proceed to Moorgate Street without delay, and the prolongations of the Great Eastern, and the London,

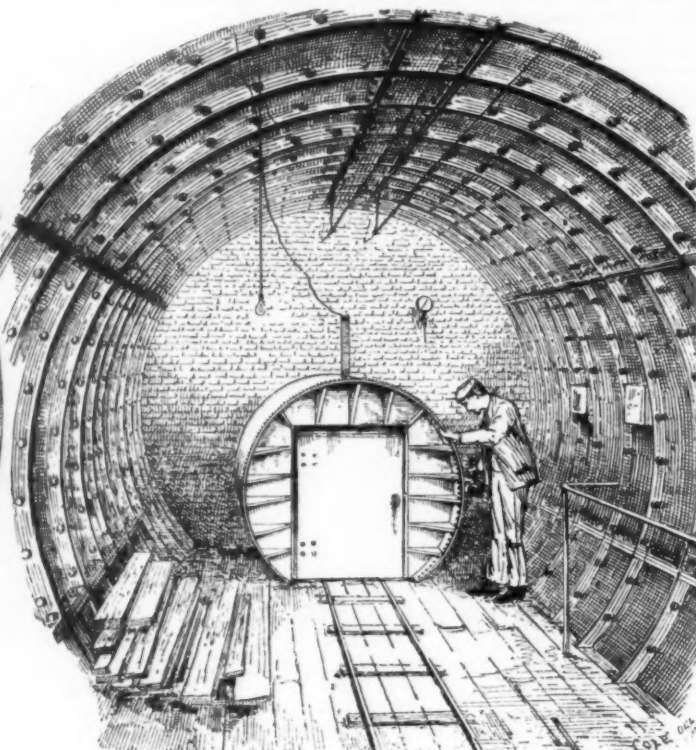
not be possible to run a five minute service on it from that station to the City, and even this would hardly suffice to accommodate the growing traffic. For these reasons and others, the directors of the Southwestern have felt that it would be very advisable for them to obtain a separate access to the City. At one time a tunnel like that of the Metropolitan Railway was contemplated, but it was seen that the cost would be so great that it could not possibly be remunerative. The next project was for an overhead railway to the Royal Exchange. It was to have cost £3,600,000, and considering the expense of building another bridge across

a joint committee to deliberate on the six schemes, including their construction and the proposed methods of traction.

The committee reported in favor of all the six bills, but the Waterloo and City is the only one of these lines that has as yet been commenced. Its total length will be 1 mile 4 furlongs 150 yards; the estimated cost of land and works is £500,000, or, including hydraulic lifts and electric rolling stock, about £600,000. The public, and even our legislators, do not always consider that if they are to have cheap fares a line must be constructed cheaply. For instance, the



VIEW AT BOTTOM OF RIVER SHAFT, NEAR BLACKFRIARS BRIDGE.



VIEW AT ENTRANCE TO AIR LOCK.

Chatham, and Dover Railways, have given to nearly all other lines an advantage over the Southwestern in competing for the suburban traffic.

In 1881 it was estimated that 797,000 persons entered the City of London daily. In 1891 this number had increased to 1,186,000, so that by the end of the century we may reckon on a daily average of 1,800,000. About half the number are conveyed by rail, and one-half of these come in between 8 A. M. and 11 A. M.

The crowded state of Cheapside, and the other thoroughfares leading to the center of the City, shows that there is not scope for any great increase in the omnibus service during these hours; and as the tendency of Londoners is to live at greater distances from their work, it may safely be said that the railway companies will have to deal with the bulk of the additional traffic. It is true that the railway from Charing Cross to Cannon Street enters Waterloo, but it would

the Thames, and the value of the land which would be required for the terminal station, it is doubtful whether even this sum would have been sufficient.

After a great deal of careful consideration, the directors of the Southwestern Railway arrived at the conclusion that the new line would have to be constructed on the Greathead system. Accordingly the Waterloo and City Railway Company was formed, having the same directors as the Southwestern Railway, of which it will practically form a branch.

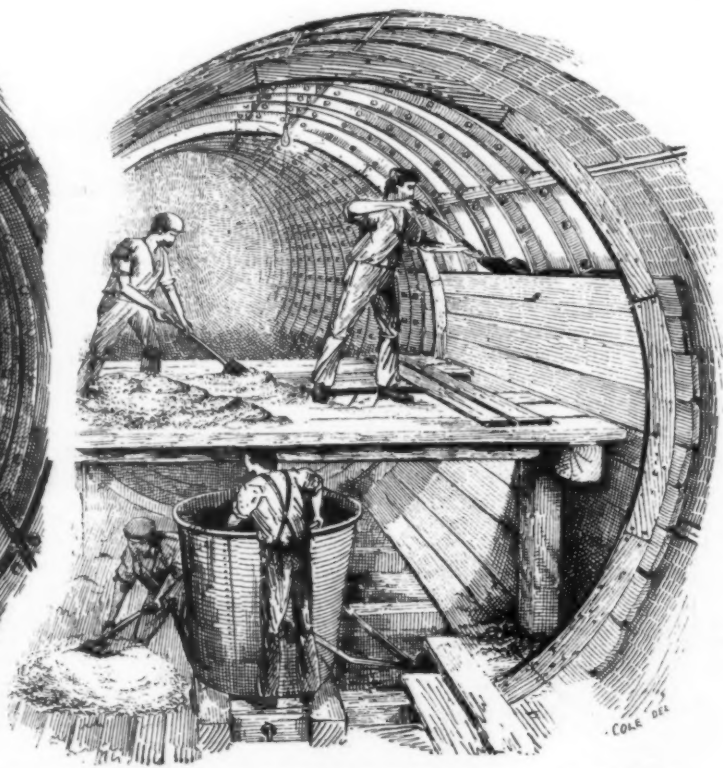
Mr. W. R. Galbraith, M.I.C.E., the consulting engineer of the Southwestern, and Mr. J. H. Greathead, M.I.C.E., are the engineers for the new line, and Mr. H. H. Dalrymple-Hay, A.M.I.C.E., is the resident engineer. In 1892 six bills were laid before Parliament for the construction of railways in the metropolis on the Greathead system. The subject was considered so important that the two houses appointed

representatives of the London County Council, and of the city corporation, both pressed upon the joint committee that the tunnels ought in every case to be of sufficient diameter to permit of ordinary rolling stock passing through them without difficulty.

The promoters argued that junctions with existing lines could not be used even if made, and that the extra cost of widening the tunnels to 16 ft. diameter, which would certainly not be less than £100,000 per mile, would swamp the scheme, but the City and County Council both persisted. However, the committee refused to accept their recommendations, otherwise it is probable that the line would never have been commenced. Even more extraordinary was the proposal of General Hutchinson, late inspecting officer of the Board of Trade, who considered that railways passing under the river should be required to construct their lines in double tunnel, one within the other, "for



MINERS AT WORK IN THE SHIELD AT THE FACE



FILLING BETWEEN RIBS AND SURFACING THE IRON TUNNEL WITH CONCRETE

THE WATERLOO AND CITY ELECTRICAL UNDERGROUND RAILWAY, LONDON.

greater strength, so that if a train ran off the line and broke the inner skin, there would be the outer skin still left to prevent the percolation or intrusion of water into the tube." As every tubular railway now or hereafter constructed in London will help to relieve the congested surface traffic, the representatives of

passages from different parts of the present Waterloo Station to the one below, but these have not been shown on Fig. 2. The line will be prolonged past the end of the platform to the south side of James Street, abutting on the Lower Marsh. From this point to Aubyn Street, a distance of about 350 ft., will come the

close to the general office of the Southwestern Railway.

As a rule the horizontal distance between the outside of two tubes will be about 4 ft., but soon after leaving Waterloo it has been necessary to reduce this to 2 ft. at the point where it passes under the Charing Cross and Cannon Street branch of the Southeastern—see Fig. 3. The abutments carrying the arch are underpinned, and by bringing the tubes closer together it has just been possible to pass between them instead of under the foundations of one of them. The

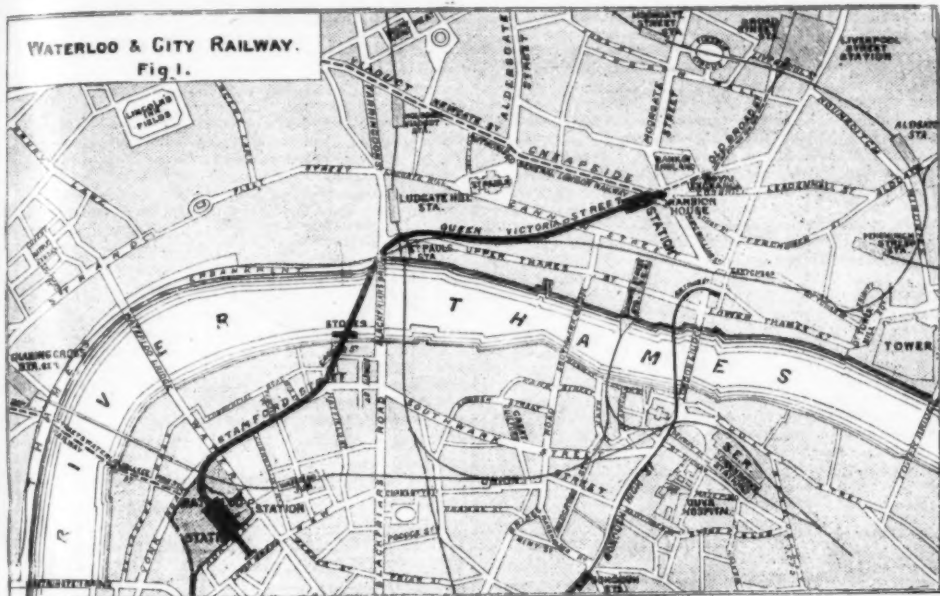
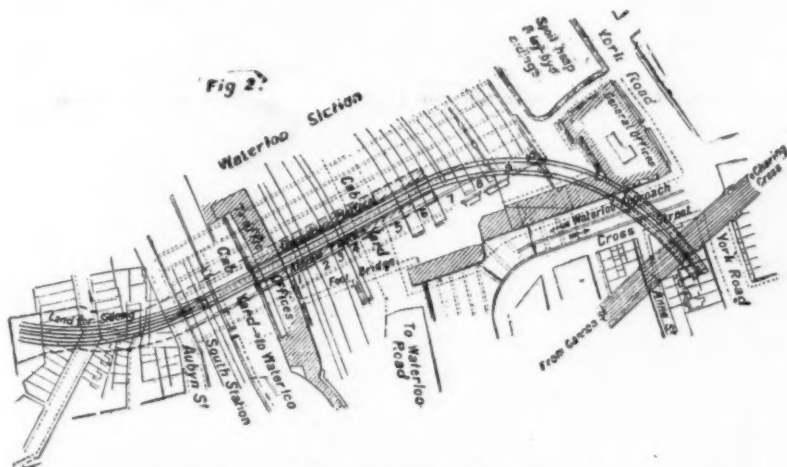


Fig. 1.—MAP SHOWING ROUTE TAKEN BY THE WATERLOO AND CITY RAILWAY.

every public body or institution should do all in their power to facilitate the work instead of raising obstacles. It seems probable that lines of this description will be required in other large cities as well as in London, and if by reasons of arbitrary stipulations their cost is increased to a point at which they cease to be remunerative, capitalists will have nothing to do with them and the taxpayer will have to find the money required for their construction.

Fig. 1 shows the route taken by the new line from Waterloo to near the Royal Exchange, where the sta-

terminal or shunting sidings, and also the generating station, including engine house, boilers, flues, etc. The Southwestern Railway station is really built on an immense viaduct, of which the piers pass through some 16 ft. of made ground, consisting of black mud, into ballast. These piers will all require to be underpinned, where they are above the new line; which will, at the station, have two separate arches, one for the up and the other for the down line. There will be inverts under these arches consisting of four or five rings of ordinary bricks set in cement; the inverts



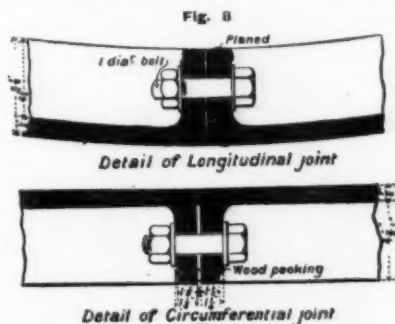
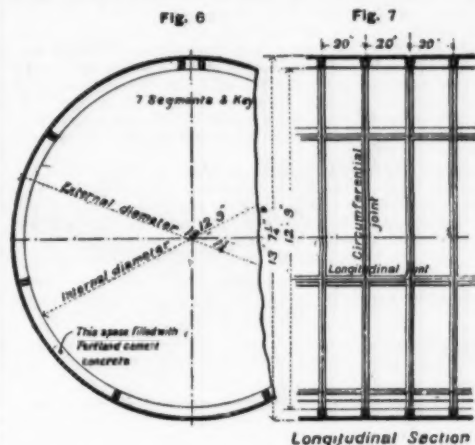
PLAN OF TERMINUS AT WATERLOO, UNDER PRESENT STATION.

tion underground will be built to accommodate both this railway and the Central London, which, as we previously mentioned, is on the point of being commenced. The details of the route will be seen more clearly on Figs. 2, 4 and 5. It commences under Waterloo Station, where the rail level will be 36 ft. below that of the Southwestern Railway. Here, as seen on Fig. 2, are the arrival and departure platforms, which are at right angles to those of the Southwestern, and extend under that part of the station covered by platforms 1 to 6, and beyond No. 1 nearly as far as the South Station. There will be staircases and inclined

serving not merely to distribute the pressure, but to keep back the water with which the soil at this part is permeated. From No. 6 Southwestern platform the new line begins to curve to the right, the radius of the curve being five chains, measured to center between the up and down line. From this point till it passes clear of the station, just under No. 10 platform, there will be cross girders between the side walls to carry the piers. This part of the construction will be "cut and cover" work, combined with underpinning. The regular tunnel work commences at the east side of the Waterloo approach, just before Cross Street, and

five chain curve extends to this point, and then a short piece of straight commences, passing under property which has been purchased on the south side of the York Road. In crossing the Waterloo Bridge Road another difficulty was encountered. In 1898, consequently long after the plans had been deposited, the County Council determined to take up the existing sewer and to reconstruct it at a lower level. This entailed the lowering of the whole line up to this point, including the underpinning at Waterloo Station, which will have to be carried to a depth of 3 ft. 9 in. below what was originally intended; and, of course, passengers will have to walk to this greater depth, since at this end there are to be no lifts. Passengers will pass from the different platforms of the Southwestern Railway to those of the Waterloo and City partly by steps and partly by inclined passages.

At the commencement of the line the two tunnels will be on the same level. The gradient as far as the end of the first curve will be 1 in 710, rising toward the City. Thence the tunnels drop at 1 in 60 to the South-eastern Railway bridge. Here the levels of the two tunnels vary; the up or western line descends at an



inclination of 1 in 30 for 900 feet, while the other or down line continues at 1 in 60. The object of this rapid descent is to get one line as soon as possible out of the water-bearing ballast into the impervious clay. It will be observed that this incline of 1 in 30 is with the load, the steepest gradient against the load at any part of the line being 1 in 60. At the end of the 900 ft. the up tunnel falls 1 in 120 to Broadwall, and then 1 in 800 to the shaft. The other tunnel has a regular descent of 1 in 550 from Broadwall to the shaft, whence they are both on the same level to the City station. From the shaft the lines are on a level for 100 feet, and then rise 1 in 800 for 1,300 feet, to a point opposite the Times office. The rise for the rest of the line is 1 in 88 to the commencement of the station, which will be between Queen Street and Bucklersbury, under the

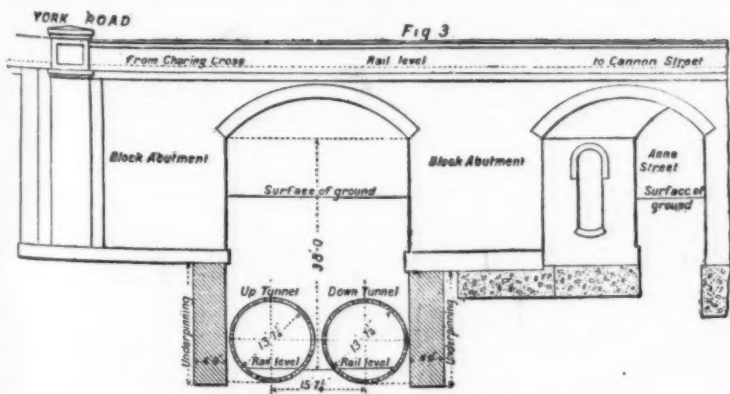
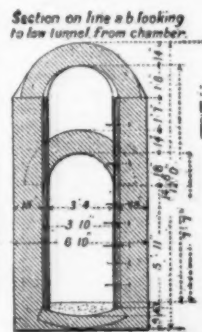


Fig. 3.—TUNNELS UNDER S.E.R. NEAR WATERLOO



SECTION A B, Fig. 10



UNDER PRESSURE IN THE AIR LOCK

THE WATERLOO AND CITY ELECTRICAL UNDERGROUND RAILWAY, LONDON.

roadway at the upper end of Queen Victoria Street, close to the Mansion House. The platforms here will be 330 feet long, and beyond them there will be a single shunting line 300 feet long, on a five chain curve, and rising 1 in 100. The rail level at the City station will be 65 feet below the surface, with which it will be connected by hydraulic lifts.

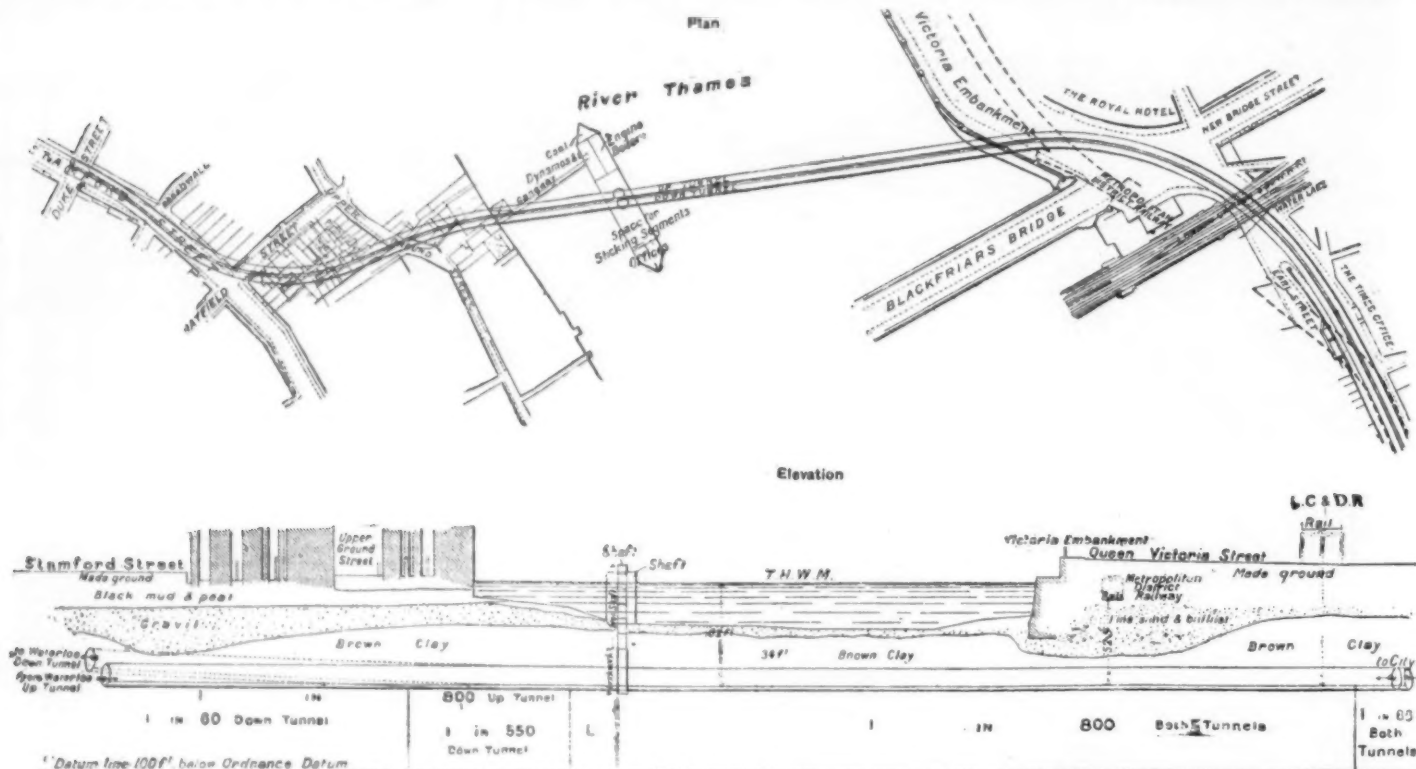
After crossing the Waterloo Bridge Road, the line will keep under Stamford Street till its intersection

Hill to Friday Street, be exactly under the District Railway, the difference between the rail levels at this part being 45 feet to 53 feet.

Figs. 6, 7, and 8 show the construction of the tubes. They are in sections 20 in. long, each section consisting of seven segments, and a key-piece at the top. The longitudinal joints are planed, and are radial to the center of the tunnel, excepting the sides of the key-pieces, which are parallel and vertical, so that they

zontal distance apart is in both cases 17 feet 6 inches center to center, except where they have to be brought closer together at Cross Street as described above.

Figs. 9 and 10 show the connections between the up and down lines, for the convenience of platelayers, etc. There will be six to Fig. 9 at regular intervals from Upper Ground Station to the City station. Fig. 10 is a specially designed communication at the intersection of Broadwall and Stamford Street, the differ-



Figs. 4 and 5.—PORTION OF TUNNEL BETWEEN STAMFORD STREET AND QUEEN VICTORIA STREET, PASSING UNDER THE THAMES.

with Hatfield Street, where it bends to the left in a five chain curve, followed after a short interval of straight by a nine chain curve to the right, which brings it to the Surrey shore of the Thames. It passes under the river in a northeasterly direction, and has no curve till it reaches the Middlesex side, just opposite the City of London School. Here a nine chain curve to the right takes it under the Metropolitan District Railway, where the rails will be 53 ft. below those of the existing line. Still keeping under the roadway, and just clearing St. Paul's station, it follows the line of Queen Victoria Street, and will therefore, from St. Andrew's

may be inserted more easily. The segments are joined together, and the separate sections are also connected by means of turned bolts 1 inch in diameter. There is no packing between the segments, but between each section there is a strip of creosoted wood $\frac{3}{4}$ inch thick. From the shaft toward the City the internal diameter of the tubes is 12 feet $1\frac{1}{4}$ inches, and the external diameter 13 feet; but toward Waterloo, in order to insure that the carriages shall not foul the sides in passing round the five chain curves, it has been necessary to make the internal diameter 12 feet 9 inches and the external 13 feet $7\frac{1}{4}$ inches. The hori-

zontal distance apart is in both cases 17 feet 6 inches center to center, except where they have to be brought closer together at Cross Street as described above.

Some little difficulty was experienced in determining suitable stations for setting out the tunnels. Early in 1894, Mr. Hay measured a base line on the Victoria Embankment; one point at Blackfriars and the other 1,253 ft. toward the Temple. From this it was possible to triangulate to an observatory placed on the Skin Hospital at the corner of Hatfield Street. But from this latter station the Blackfriars end of the base line could not be seen, so that it became necessary to fix a point further back on a building in New Bridge Street. Before this could be done, another point on the Surrey side was needed. When the triangulation was finished, a second or check base line was measured across Blackfriars Bridge, and the difference between the measured and calculated lengths of this second base line was only $\frac{3}{8}$ in. All measurements were taken with steel tapes.

(To be continued.)

POUNDING ENGINES.

If there is any one thing a new engineer prides himself upon more than another, it is in his ability to locate a pound in his engine, and as a general thing

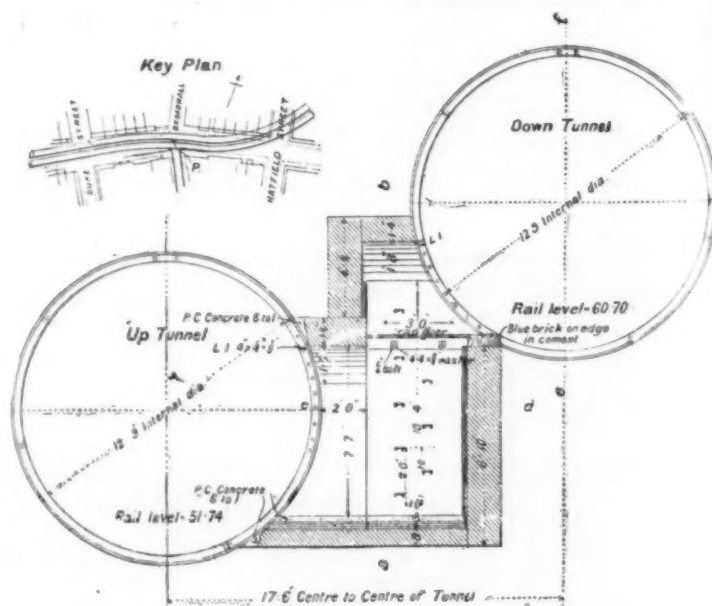
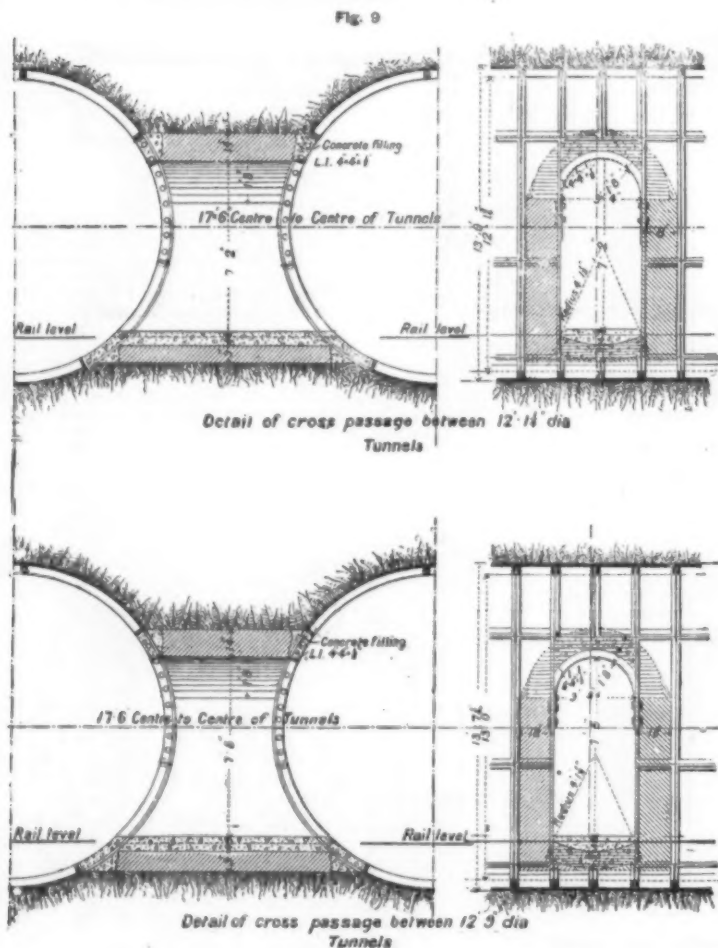


Fig. 10.—CONNECTION BETWEEN UP AND DOWN LINES IN STAMFORD STREET

THE WATERLOO AND CITY ELECTRICAL UNDERGROUND RAILWAY, LONDON.

it is the very thing which sets him to looking just where it isn't for it.

An amusing instance of this happened in my own experience several years ago, when an engineer in charge of a little 15 horse power engine, I was exceedingly troubled over a stubborn pound and started in to locate it. At first I was sure it was in the connecting rod, then it changed into the wrist pin, driven from there it located in the main journal, then in the outboard bearing, and finally we came to the conclusion it must be in the piston. All this time I was very sure I knew where it was, and often said to the engineers that I would stop it when I got ready, at the same time making a note of all suggestions offered by those who had happened to hear it; but still the pound seemed to increase rather than diminish, until I was inclined to think my knowledge might possibly be unable to cope with the case. One day a very quiet, unobtrusive individual came into the engine room from another department, and knowing him never to intrude his ideas upon any subject unsolicited, I asked him where he thought the pound was putting in its work just at that particular time. He very quietly moved about the machine, feeling his way along from the cylinder outward until he had crossed to the shaft, when with the utmost deliberation he pointed to the drive wheel. In order to convince him that he must be wrong I shut the engine down, struck the wheel key once or twice, and turned up the set screws. Then starting up, I watched his face to see the look of chagrin at being so far from correct, when, much to my surprise, I found the machine running more quiet than it had for several days.

or the collar at the end of the pin. It is rather uncertain for one person to manage the lever and feel for the looseness also, as the motion given the body in working the lever will detract from the sensitiveness of observation regarding the amount of play at the connecting rod.

The use of a lever in this way will detect any looseness that may exist at any joint so tried, especially on the connecting rod at crank or crosshead end, the play of crosshead between the guides, the looseness of piston rod in the crosshead or of piston head on the rod; a little ingenuity is often required in rigging this device so as to bring force into play to give the shaking motion required, but if the lever is properly worked, the slightest play can be detected.

Another way which is much used by engineers on four-valve engines is to throw the crank on the center, block the steam valves so to fill both ends of the cylinder with steam, and then by opening the exhaust valves first at one end and then the other, the shaking of the rod may be done without the trouble of a lever.

Many times a looseness will cause a heavy pound in the engine that, because it cannot be detected in the connecting rod, will be supposed to exist in the cylinder, when as a matter of fact it is the main journal that causes the trouble. A looseness at this point is more difficult to locate than at any other, especially when the box is separated at an angle, as any tightening on the cap will cause the bearing to heat without removing the cause of the pound. Bearings set in this position carry a portion of the weight of the shaft at the point where it is separated, which permits greater wear in this direction than would be the case where

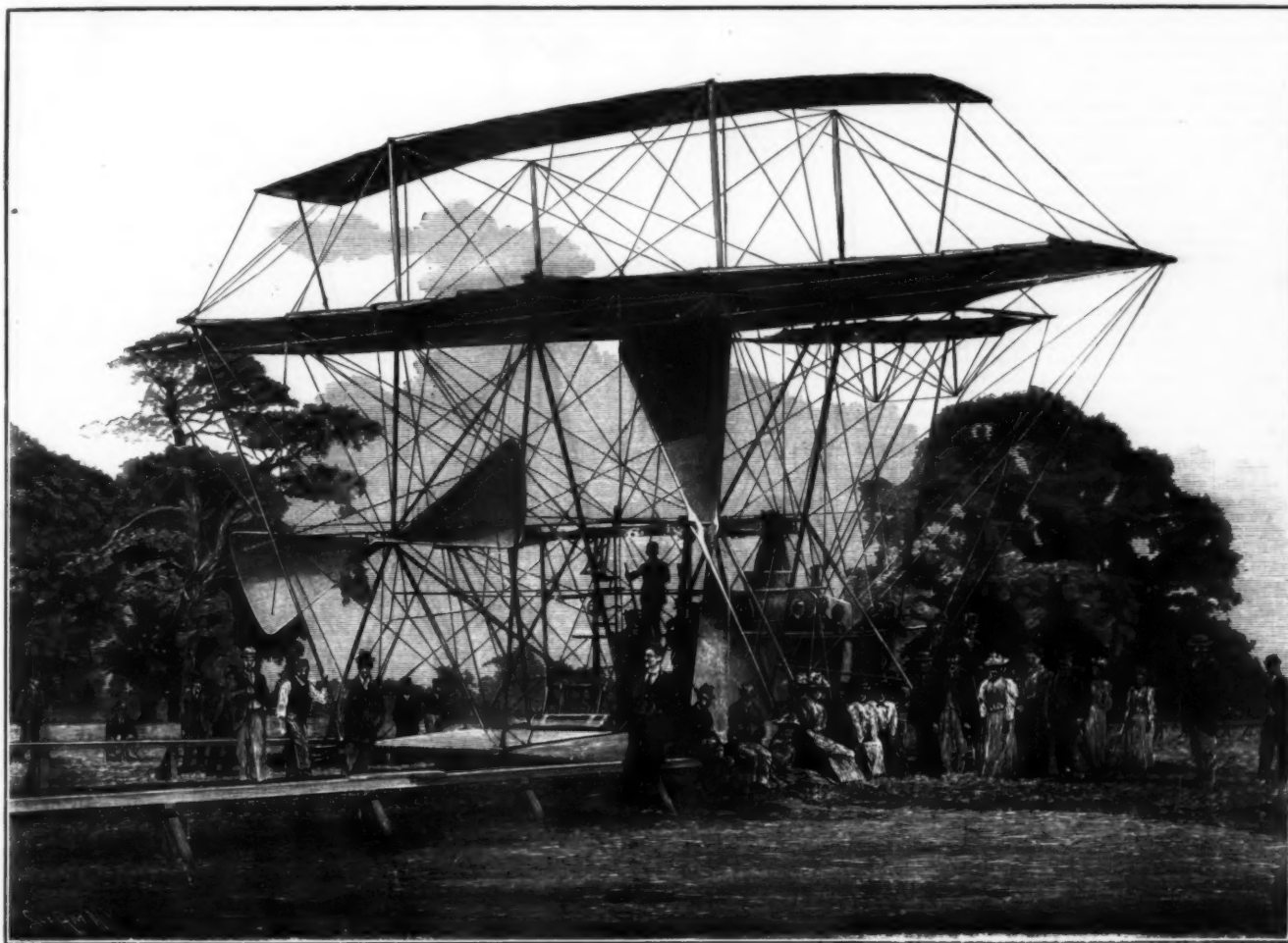
A good time to test this shaft is when the engine is running, as then the end of the finger can be held so it will press on shaft and boxing, and any jumping of the shaft can easily be detected, although this is not practical on some engines where the eccentric comes close to pillow block. When the latter is the case, a lever of sufficient strength can be rigged to shake the shaft if any necessity exists for such an arrangement.

Sounds that appear to proceed from first one place and then another about the engine can generally be located by the use of a piece of rubber tubing, one end of which is held to the ear while the other end is brought close to the suspected place. The opposite ear should be closed to shut out the sound. Ingenuity and facility for research are necessary in an engineer, if he expects to wrestle alone with all the difficulties which come up in his engine room experience, and the one who tries to run his engine by some one else's rules is quite sure to find his employer calling for that some one else to adapt those rules to this particular place.

An old yet very effective way to locate any noise inside of an engine cylinder is to place one end of a wrench or other piece of metal between the teeth, and resting the other end on the cylinder head, close both ears. Every sound within the cylinder can thus be readily heard.—Rex, Lord's Magazine.

ANOTHER TRIAL OF THE MAXIM FLYING MACHINE.

On Friday, July 5, a large party of scientific men paid a visit by invitation of Mr. Hiram Maxim and Mr.



MAXIM'S FLYING MACHINE

How did it happen? Why, he knew just what he was about and I didn't, that was all; and being placed in his position a few days ago, I think a few words on the subject will not come amiss. There are but few things which will cause an engine to pound heavily, and with a knowledge of these and careful investigations, the cause of the trouble may be located and removed. If the connecting rod connections are quite loose, the engine will probably pound whether there is much or little compression, and one of the first things that should be tried is to locate the source of the sound. If this cannot be done, then a few tests can be made which will in all probability discover the cause. With the cause known, the remedy is obvious.

When looseness at either end of the connecting rod is suspected, but is not plainly evident, the engineer should go carefully at work to ascertain whether there is any lost motion at the suspected part before keying up any. In the case of a connecting rod it is well to put the engine on the center when keying up, as the tendency is for the crank pin to wear flat on one side, and if keying is done at any other point of the crank travel, the boxes may be brought too tight, which would cause heating.

The crosshead pin always wears more on the sides than on the top, leaving the pin somewhat elliptic in section, and that is why a portion of the brasses are cut away along the sides where they would come together when encircling the pin.

Before keying up, it is a good plan to arrange a short lever on some convenient fulcrum, so that pressure can be brought to bear to shake the rod up and down on the pin, or on the collar at the end of the pin, as when this is done the extent of the lost motion can easily be detected by placing a finger so it will press on the pin

the separations were horizontal; any attempt to tighten a cap of this kind will bring the corner of the box lining more forcibly against the shaft, causing it to heat so that tightening the journal cap would be no indication that the box was in proper condition and the journal might heat while still pounding.

A 150 horse power slide valve engine had caused considerable annoyance for some time by a dull, heavy thump at each revolution, just about the time the crank had passed the center. The engine was running 150 revolutions per minute, and the thump was sufficient to jar the building. The engineer in charge had made several attempts to locate the sound but without success. A new man taking hold of the engine studied it for some time, trying to ascertain the location of the noise, but could not do so by ordinary means. All but the joints, it was thought, had been adjusted without any better results. A lever was then brought into play to lift each end of the connecting rod so as to show any lost motion that might exist there, for when the rod is shaking up and down, and the finger is held so that it is pressed on the brasses and pin at the same time, any looseness can be readily detected. This method was applied to crosshead, eccentric and other parts without discovering any looseness. Outside the cylinder and valves the only part left to be investigated was the shaft bearing and fly wheel. When a long lever, consisting of a 2½ inch pipe, was brought to bear on the crank end of the shaft, a looseness that had not been discovered was found to exist at that point. The journal cap was taken off and it was found that it had never been correctly adjusted, as it had worn oblong; and during every revolution the shaft would jump first in one direction and then in the other, on a line with the push and pull of the connecting rod.

Brodrick Cloete to Baldwyns Park, Bexley, to witness a trial of the celebrated flying machine, and the latest development in the direction of mechanical flight. We make an abstract from an account thereof by Prof. A. G. Greenhill, given in Nature.

The invitations were carefully distributed among those who were competent to judge of the magnitude of the task to be attempted, and who were prepared to examine closely the ingenious mechanical details by which it was clearly demonstrated that the machine had ample power to lift itself off the ground, carrying with it a supply of fuel and water, and a crew for the navigation.

The Bexley machine is purposely designed of extreme size, with the intention of thoroughly testing and elaborating the details of the mechanism, and of measuring the lifting power, within immediate reach of a workshop and skilled mechanics, more than of actually taking to the air; this will probably be first attempted with a much smaller machine, capable of lifting one man, of jockeylike proportions, and mounted on a boat on a lake, so that short flights, like those of a flying fish, can be attempted for initial practice.

The lifting force of the machine is measured automatically as it runs along a railway track about half a mile in length, and the machine is prevented from taking to flight by wheels running underneath the outer wooden rails, for much yet remains to be done in the way of practice in vertical steering before taking leave of the earth; the chief difficulties of the aviator beginning when he wishes to descend and alight on the ground again.

The Bexley machine, complete with the water, naphtha fuel and crew of three men on board, weighs 8,000

lb.; and running at forty miles an hour with a pressure of 275 lb. per square inch, the engines develop 360 horse power, the thrust of the screws is 2,000 lb. and the lifting effect of the aeroplanes and wings, 4,000 square feet in area, is 10,000 lb.

A thrust of 2,000 pounds at 45 miles an hour gives 240 thrust horse power; or, with a speed of advance of the screw of 60 miles an hour, 330 indicated horse power.

The total projected disk area of the screws is 500 square feet, each screw being nearly 18 feet in diameter, with a pitch of 16 feet; and thus requiring 330 revolutions a minute to give a speed of advance of 60 miles an hour.

Mr. Maxim calculates that, after making all allowances, he can at present lift 28 pounds per horse power; but that, with improvements, he hopes to raise this figure to 50 or 60 pounds, and then a machine could take a flight of 500 or 600 miles.

When the machine is perfected, Mr. Maxim claims that the railway track may be dispensed with; and that a short run over a moderately level field will enable it to attain the velocity necessary to rise. As far as landing is concerned, he says that the aerial navigator will touch the ground while moving forward, and the machine will be brought to rest by sliding on the ground for a short distance. In this manner very little shock should result, whereas if the machine is stopped in the air and allowed to fall directly to the earth without advancing, the shock, though not strong enough to be dangerous (?) to life or limb, might be sufficient to disarrange or injure the machinery.

These numbers are taken from Mr. Maxim's lecture on "Experiments in Aeronautics," before the Society of Arts, November 28, 1894, where a full account of the mechanical details will be found. Each engine is a two-cylinder compound, with the cranks set at 180°; in this way the inertia stresses are self-contained, and racking of the framework is avoided; a similar arrangement is adopted by Mr. Thornycroft in his recent torpedo boats. A photograph showed Mr. Maxim lifting with ease one of these engines, from which 180 horse power can be developed. The boiler is, if possible, a still more wonderful miracle of lightness for its power, weighing only 1,000 lb., and providing 360 horse power; the fire is given by a steel burner with 14,000 jets, made from the naphtha vapor delivered from an automatic gas generator. For details the reader must be referred to Mr. Maxim's lecture; but the chief result arrived at may be summarized as a performance of one horse power for every 11 lb. of weight in the motor complete.

At this rate a 10 horse power motor can be produced which will weigh considerably less than an ordinary man; so that when Mr. Maxim can spare a little leisure from this fascinating problem of flight, he can beat easily the performance of the steam carriages recently competing in France, and carry off, we hope, the prize of £1,000 offered in this country by the proprietors of the Engineer; and some day we may see his motor utilized for purposes of military traction, and galloping round the smartest battery of artillery on Woolwich Common.

Mr. Maxim eschews the gas bag of balloons, and the use of vertical screws for securing levitation, and he relies entirely on the upward thrust on the aeroplane and wings, mounted at a slope of about 1 in 8, due to the currents of air rushing past them.

These surfaces are formed of canvas, stretched on a skeleton framework of hollow steel rods for the struts and thin steel wire for the ties; the large central aeroplane is composed of two parallel canvas surfaces, with a space between, and in this way the shape is preserved better; and the general set of the wings, smooth like cardboard, should excite the envy and stimulate the imitation of our sailmakers for yacht racing. The front and rear wings are shown pivoted about a horizontal axis, so as to act as rudders in a vertical plane.

The machine is tied up to the indicator post in its rear; the propellers are then set in motion, and soon drive a gale of wind in their wake; when the pull of the rope has reached a definite amount, say 2,000 lb., a hook is released, and the machine starts on its journey along the track. Mr. Maxim can now carry out his original notion of experiments with a model machine, tied to a post, in a gale of forty miles an hour, to be found every afternoon in the cañons of California, in an artificial gale produced in the wake of his propellers. Dynamometers register simultaneously the thrust of the propellers, so that much interesting information concerning the dynamics of screw propulsion can be obtained here, especially if Mr. Maxim will stretch a wire carrying ribbons across the axes of the propellers, in front and in rear, to measure the direction of the air currents. The speed in air Mr. Maxim deals with is about double the speed of the torpedo boat in water; but the effect of "cavitation" in water, which is beginning to trouble the naval architects, is one which will not concern the propeller working in air.

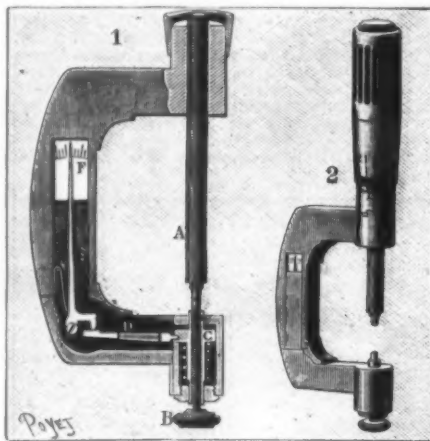
Now that the main mechanical difficulties of construction have been overcome, a longer track is required for the purpose of practice in vertical steering while the machine is off the ground, but bearing upward against the outer rails. It is unfortunate that difficulties should have been thrown in the way of making an extension of the present track beyond the domain of Baldwyns Park; so another practice ground, perhaps a sheet of water, must be found, not too far from headquarters or from skilled assistance.

A. PALMER'S SCREW GAGE OF CONSTANT PRESSURE.

EVERY one is acquainted with the very practical instrument called a screw gage, that permits, through a micrometric screw, of measuring diameters and thicknesses with a certain amount of precision, although exact precision cannot be obtained unless the pressure of the screw remains constant. In most cases, such pressure scarcely varies, and the errors are negligible. But the same is not the case if it is a question of measurements of very high precision directed to hundredths of a millimeter. Captain Leneven has constructed an apparatus of this kind provided with an arrangement that permits of keeping the pressure above mentioned always constant. The accompanying figure gives an external and internal

view of the apparatus. Like all instruments of the kind, it is formed of a micrometric screw, A, with graduated cylinder and vernier. The nut, C, of the screw, B, is provided with a pressure indicator movable around an axis with transmissions by levers, D and E. A spring, R, placed at the side presses lightly against the rod, E, and holds it in place. The prolongation of this rod displaces itself at E upon a graduation arranged to this effect. The levers are concealed in the interior of the instrument and the graduation alone is apparent, as shown in No. 2 of the figure. At the beginning of a measurement, the screw, B, is regulated by means of its milled head until the needle, F, keeps at zero. During the measurement this needle should not vary its position; if it does, it indicates a difference of pressure. On taking these precautions, we obtain measurements of very high precision, the results of which are comparable when it is a question of measurements made by various observers.

This apparatus is very sensitive. It suffices to hold it in the hand for a few instants to remark a deflection of the needle, which is caused by the difference of

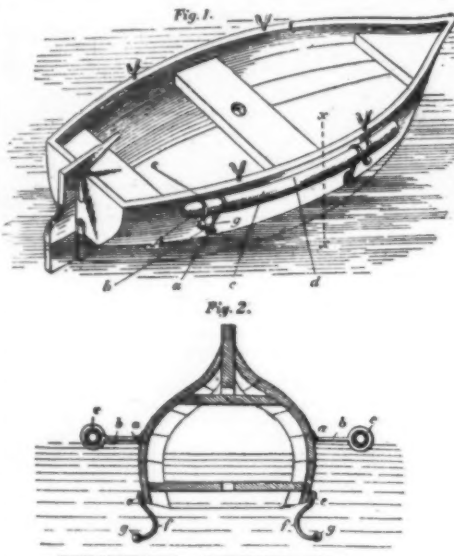


AN IMPROVED SCREW GAGE.

pressure produced by the curve of the instrument under the influence of expansion. The effects are certainly not very considerable, but they are indicated very clearly for so feeble a difference of temperature. The apparatus is certainly a very simple one, and very useful for accurate measurements.—La Nature.

UNSINKABLE BOAT.

WALDEMAR VON RUEDINGER has invented an arrangement of floating tubes with a view to prevent small boats from sinking. The apparatus is described in the latest collection of consular reports. The tubes are intended to be employed in a manner similar to that of a life preserver, and fulfill this intention by keeping even a capsized boat afloat, so that persons in the water can support themselves by simply taking hold of the tubes. The contrivance can be attached to all boats of lesser dimensions, such as life-boats, skiffs, gondolas, canoes, etc., without in the least interfering with their locomotion. Unless a boat is made to sink by overloading it, the floating tubes, it is claimed, prevent the possibility of its filling with water.



Whereas until now persons who had fallen into the water were unable to rescue themselves by means of a capsized boat, the latter, when supplied with the floating tubes, furnishes an excellent means of support. Fig. 1 shows the floating tubes attached to a skiff. Fig. 2 represents a cross section of the same boat when capsized and sustained by the tubes. On both sides of the boat are attached two steel eyes, a, over which bands, b, operate and sustain the watertight tubes, c. The latter are furnished with an arrangement to admit air, and are so attached that their center line corresponds with that of the boat. For the purpose of holding the tubes in place, bands of oval shape working in eyes and weighted at the free end, g, are attached to the boat's outer planks. By reason of this arrangement of the various parts, the capsizing of a boat becomes, it is claimed, almost a matter of impossibility. Should this occur, however, because of oversight, the

weighted bands turn on their eyes, simply swing down, and free the tubes. The latter, in their turn, being filled with air, also move, but in the opposite direction, and float on the surface of the water. At the same time, watertight rings of similar construction as the tubes would turn on ball joints, and, together with the tubes, keep the boat afloat. Then all the shipwrecked persons need do would be to take firm hold of either rings or tubes.

THE MANUFACTURE OF VIOLIN STRINGS IN SAXONY.

It is generally supposed, though it must remain a matter of conjecture, owing to the lack of reliable information on this point, that the manufacture of gut strings (the name of catgut is misleading, for all the "catgut," so called, sold in the market for stringing musical instruments and for medical purposes comes from the sheep) was transplanted to the town of Markneukirchen, through immigrating Protestant Bohemians during, or soon after, the Thirty Years' War (1618-1648). Some men of Markneukirchen had acquired the trade and bequeathed to their sons the secret, for such it was considered, especially the knowledge of the component parts of the lye used to bleach the sheep gut. The United States Consular Agent at Markneukirchen says that in the year 1777 the union of string makers was founded, and, in 1781, had a membership of 13, which increased to 36 in 1793. To join the union the applicant had to perform the chief work without the least assistance, under strict surveillance of one or more of the union's members. The work had to elicit the entire satisfaction of the representative men of the union, and consisted of one bundle (thirty pieces) of E strings; half a bundle (fifteen pieces) of D strings; half a bundle of A strings, and one complete set wherewith to string a violone (the largest instrument of the base viol kind). If this task was finished satisfactorily, the workman was accepted as a brother member, and his employer was, by contract, under obligation to give him a good recipe for making a bleaching lye. This was, therefore, given to him, but, as a matter of fact, none of the masters parted with their individual secret, only leaving it, after death, to their sons or next of kin. All inquiries made on this subject lead one to suppose that, at present, potassa lye is generally used. About seventy-five years ago, Markneukirchen used Bohemian and Bavarian sheep gut, but later on, Prussia furnished a fair supply. Within the last decade material for making strings has been obtained from England, Russia, Denmark, Spain, Bulgaria, Turkey, Java, Damascus, and Jerusalem. The intestine needed for a musical string must be from a lamb born in the spring and slaughtered not later than October or November of the same year; those from the older sheep can be used only to make bass strings or for other minor purposes. The prices vary in accordance with the time of the year at which the sheep was killed. In the manufacture of strings, the dried intestines are first placed in earthen vats containing a potassa lye, where they are left for 24 hours. After the lapse of this time they are sufficiently soaked to permit unraveling, for, in spite of the bath, they still adhere. They are then placed in a fresh potassa lye; the strength of the lye must be regulated according to the age of the sheep when killed, and must be weaker for the intestine from the spring lamb than for that from the six to nine months' old sheep. For eight days in succession the bath is daily renewed without varying the strength of the lye. Beginning from the second day, the intestines undergo, at various times of each day, the most thorough cleaning by girls armed with the "sliming" or cleaning iron. The intestine is drawn between the first finger, covered by a gutta percha glove, and the thumb of the left hand, the sliming iron or ring being held with the thumb. By this act are removed the external (peritoneal) and mucous membranes, leaving only the muscular or fibrous membrane used to make a string. After the above described proceeding has been attended to daily for three consecutive days, the intestine is sufficiently fluid to be split into two parts, by being drawn across a blade of a sharpness exceeding that of a razor, firmly fastened to a handle, which in turn is affixed to an upright. The sliming is now continued; this was formerly done by hand, but is now done by means of a machine. Here the intestine is drawn over five upright blades, above which, securely fastened, is a 25 lb. gutta percha weight, that bears down on the intestine with the required pressure. Four days more of this proceeding suffice to get the intestine ready for the workman, experienced in sorting the parts according to quality, thickness, and length. It must be noted that there are two qualities resulting from one gut; for, on being split in two, the adhesive (inner) part is not even or smooth, and can therefore be used only for the inferior qualities. The number of parts needed for any one string depends upon the thickness of the intestine. For instance, to make an E string from Russian gut, four to six parts are necessary; from English sheep gut, three to four parts, because the Russian is finer than the English gut; at least three parts are taken to make a string. A violin A string is double the size of an E string; therefore parts of double thickness are used, but the same number of parts that are required for an E string. Again, a D string, being three times as thick as the E string, 15 to 20 parts of the intestines from the spring lamb are used when a fine quality D is desired; for, as already pointed out, the intestine from the sheep killed in its earliest stage is too weak for an E string, but answers very well where a large number of parts are joined. The bass strings are made from the unsplit fibrous membrane; 30 to 50 entire (unsplit) parts are taken for a G, 45 to 75 parts for a D, and 60 to 90 parts for an A bass string. The following processes up to the time when the finished strings are placed in the sulphuring chamber must be performed on one and the same day to prevent putrefaction. The parts selected to make one string are attached at both ends to hempen loops; one of these is fastened to one of two hooks in the center of a little wheel, stationed at one end of the inner part of a frame, the intestinal parts twisted round a fixed peg, at the other end of the frame opposite the wheel, and the second loop brought back to the wheel to be attached to the second hook in the center of the wheel. The latter is now rapidly revolved by a connecting multiplying fly-wheel, and the parts thus twisted into a string. The

moisture brought to the surface by the twisting is removed, and the strings are taken from the frame and placed in an airtight sulphuring receptacle, where they are left overnight. On the following morning they are exposed to the air, which furthers the bleaching process, till nearly dry, when they are again slightly moistened and replaced in the sulphur bath. This operation lasts from 8 to 10 days, the length of time depending on the weather. The best and whitest string, aside from the result of the sulphurous acid gases, is that which has had frequent exposure to the air in clean, balmy weather. Excessive bleaching by means of sulphur heightens the whiteness at the expense of the quality. The strings must never be exposed to the sun if the heat resulting exceeds a moderate temperature of 75° Fah. After the bleaching, the string is subjected to a rubbing with pumice stone, to bring it down to the correct size, which removes, at the same time, any existing inequalities. The requisite polish is mainly due to frequent wipings with olive oil. Following this, they are again left to dry in the air, to be there cut, rolled, and assorted according to color. Thirty strings of the same size and whiteness are made up into a bundle. From the time that the dried intestine is first placed in the dye to the time when the finished strings are assorted and ready for the market, 18 to 20 days elapse. During this period, not a day passes without the intestine or the partly finished string being subjected to manipulation of some sort. It is generally supposed that a musical string loses both its color and quality, if kept in stock for a comparatively short period, but, while the color is impaired in the course of time, the quality does not deteriorate, provided the strings are stored in hermetically closed cases, in an even and dry atmosphere.

OXYGENATED BEVERAGES.

PRIESTLEY, enthusiastic over the properties of oxygen that he had just discovered, wrote in 1774: "Who can assert that this pure air shall not hereafter become an object of luxury much in vogue?" In 1777, Ingenhousz, of Rotterdam, found that inhalations of oxygen rendered him more robust, increased his appetite and afforded him more tranquil sleep. In 1784, Mozzo ad-

shops where apprentices are taught to do its fine handiwork. The tendency now is to substitute factory work for these, and even where workshop apprenticeship can be obtained it is under disadvantageous conditions. But in the city schools the girls are guarded in a healthful and inspiring atmosphere, and may learn their trade thoroughly, relieved from any pressure of the market.

The mornings are devoted to the regular school course, which includes also plain sewing, drawing, bookkeeping, and English. Then follows an hour and a half for luncheon, but this does not mean a cold sandwich and an apple. To each school belongs a cook, presiding over a large kitchen. From this the girls receive a hot luncheon; either they bring their own meals, which are warmed in the oven, or, by paying six or seven cents, are furnished from the school canteen with soup, meat, and vegetables. If a scholar is unable to provide for herself, the administration allows her a purse for luncheon, and sometimes for clothes, during the apprenticeship. In one school I found that seventy-five were fed and twenty-five clothed in this way.

At a quarter of one each girl works at the trade which she has selected—dressmaking, industrial art, artificial flowers and feather-work, embroidery, millinery, laundry-work, or corset-making. The course is three years, and a fourth is sometimes granted. In the embroidery department one sees rows of busy heads bent over exquisite work; some are doing simple forms of appliqué, two will be absorbed over a Louis XV pillow, sometimes four will be at work on the corners of a table-cover; others bead tulle for ball dresses, or make anchors on boys' sailor suits sent in from the dressmaking department. The most advanced make the heavy gold embroidery on priests' robes and the uniforms of prefects and members of the French Academy. They work with their own copy of the design before them, as all have six hours of drawing a week, and also instruction in water-color.

In the millinery department little unskilled fingers begin by bungling over the frame of a doll's hat, and graduate ready to make those most exquisite of Paris creations, its bonnets. The French artificial flowers are admired by artists, but even botanists may find

vate dining-room by themselves and one or two teachers. The recipes are all written carefully in their books. They follow a menu for each day of the week, and, as they study housekeeping for a week four times a year, the menu changes, and they learn the main dishes of each season—soups, meats, vegetables and desserts. Besides the cooking, each day has its special duties. On Monday they wash, taking the linen of the school or something from home; Tuesday and Wednesday they iron; Thursday they clean the brasses all over the house, and the rest of the week sweep, scrub, dust. There are also included all the little side duties belonging to housekeeping, such as the waxing of furniture according to the French custom, the cleaning of gloves or the taking off of spots, all the rules for which are written in their books.

In the afternoons, when their domains are shining and in order, they sit in a cozy group around the housekeeper, and learn to hem dish-towels, piece the worn places in tablecloths, or do any necessary household mending. When they leave the kitchens at five o'clock these are as pretty as could be imagined. Over the range glisten blue and white tiles and shining copper saucepans, the red-tiled floor is spotless, and all the wood is as white as if just cut from the tree. On the wall hangs a chart illustrating the different cuts of meat, while the brass scales on which they learn to weigh are polished like mirrors.

The schools are governed by a council who are sometimes chosen from the workmen's unions, and the teachers are usually well advanced in pedagogy and sociology. The whole atmosphere of the school is that of the cordial and equal companionship of family life. Many of the teachers are married women with children; in fact, in several cases I found substitutes presiding, as the regular teacher was at home with her new baby. The scholars work for the school as for a home, embroidering curtains and chairs, decorating the walls, making stained glass windows, beautifying it wherever they can. While most of them are from the ranks of the poor, one sees here and there daughters of janitors and under-clerks walking arm in arm with the children of the rich bourgeoisie, all wearing the black apron so popular for Parisian children. Many of them never use what they learn except in their own homes, but the majority are self-supporting, and the alumna associations become veritable employment bureaus for them. On graduation the city presents each girl with a savings bank book, and a small account varying somewhat according to the scholarship.

One defect I found in all the schools. The girls bend over their work from a quarter to one to half-past five, six days of the week. About three o'clock they have fifteen minutes' recreation, but gymnastics are rarely given. There is, therefore, no parallel cultivation of the body with that of the mind and hands. I was everywhere told that it was necessary for the girls to be prepared in this way for the exacting hours which awaited them in their trades. I thought, too, as I saw one class working hard and fast over an order of vests for the Bon Marché, that the schools might become tainted with real commercialism. One looks to education to give to the young a period of ideal glimpses. Perhaps, however, this scheme, so practically adjusted to existing conditions, is wiser, and the defects will disappear from the schools only when they are rooted out of the surrounding society.

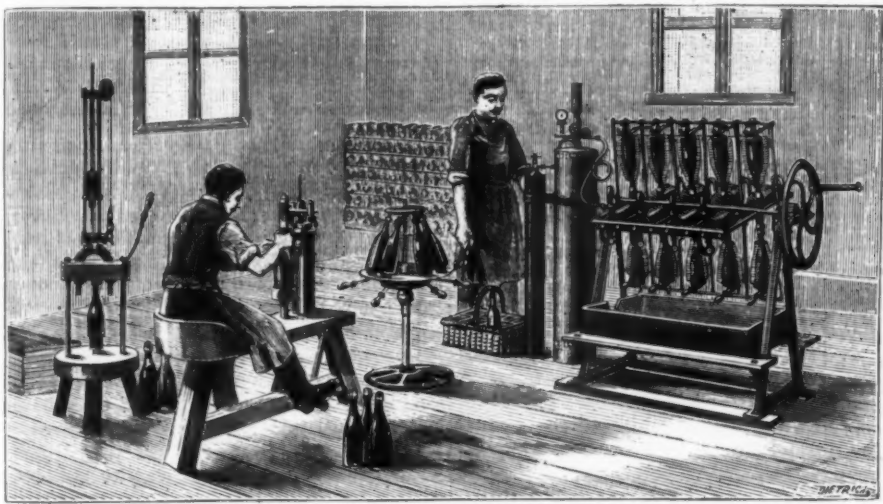
The first of these schools were started by individuals, from humanitarian sentiments, and afterward bought by the city. In our New York public schools manual training is being rapidly introduced, and in Brooklyn there is already one beautiful school, Pratt Institute, modeled after those of Paris, but not, like them, free. Let us hope that many others will follow. Who shall say that this training is not equal in usefulness and pleasure to the curriculum of simply 'osophies and 'ologies, which has wearied so many fresh spirits, and which is the only preparation that so many of our girls receive for married life? Would not such schools, if they did nothing else, go far toward solving our domestic service problem, by educating both mistress and maid.—The Outlook.

SPECTRUM ANALYSIS.—I.

By J. J. STEWART, B.A. Cantab., B.Sc. Lond.

WHEN sunlight passes through a prism or wedge-shaped piece of transparent substance, it is bent out of its course; and if the source of light is a narrow slit—for example, if the light from the sun is made to pass through a small opening in a shutter—the beam of light is spread out after passing through the prism, and if it is received on a screen the image of the slit will consist of a broad band of various colors, red at one end and blue or violet at the other. This bright and many-hued strip is the solar spectrum, and its origin is due to the fact that the amount of bending or refraction which takes place on the passage of light through a prism depends on the color of the light. Blue light is more refrangible than red, i.e., it is farther bent from its original course, and, therefore, shines on a different part of the screen from that which is illuminated by the red rays. The splitting up of the rays which occurs on the transmission of light through a prism shows that white light is of a composite nature—that is to say, it is made up of rays which differ in color and refrangibility.

If sunlight be admitted through a small hole in a shutter, so as to fall on a prism placed with its refracting edge horizontal and its base uppermost, the light will be refracted and bent upward, and may be received on a screen placed at a distance. Now, if the prism is gradually turned round an axis passing through the center of the prism, and parallel to the refracting edge, so that the colored spectrum produced is more and more bent downward, and moves down the screen as the prism is turned, it will be found that at a certain point in the rotation the spectrum becomes stationary; and on continuing the rotation of the prism in the same direction, the image begins to ascend and gets higher and higher on the screen. The position of the prism when, after descending, the colored image of the sun turns and begins to go upward, is called the position of minimum deviation. For that particular position the rays are least deviated from their original course, and they make equal angles with the faces of the prism at incidence and at emer-



APPARATUS FOR THE MANUFACTURE OF OXYGENATED BEVERAGES.

vanced the same conclusions before the Royal Society of Turin. Since then many physicians have experimented with oxygen, and, despite a few contradictory results, have reached the conclusion that it is an excellent medicament in respiratory disorders and as a disinfectant. Its use is much recommended in the treatment of albumenuria and diabetes.

Up to the present, only the gas or siphons of water saturated with it have been used. It has been impossible to generalize the use of oxygen because of its dearth, which is inexplicable, and, on another hand, because of the but slightly practical and attractive form under which the product is delivered to consumers. Some new tentatives have just been made in the way of using oxygen for saturating refreshing beverages, such as lemonade, orangeade, etc. Such beverages are prepared in a very simple manner, like seltzer water or gaseous lemonade, with an apparatus like that of Bartelt, shown in the accompanying figure.

The beverages are delivered in bottles like ordinary lemonade. Their use is very healthful, especially in summer. They are recommended to diabetic and anemic persons, etc. They stimulate the digestion.—La Nature.

TRADE-SCHOOLS FOR GIRLS IN PARIS.

By CARO LLOYD.

BESIDES teaching manual training in all its public schools, Paris has since 1871 supported trade-schools, which now number twelve, six for boys and six for girls, and cost 1,600,000 francs yearly. Each one of the boys' schools is devoted to a separate trade, such as bookbinding, printing, engraving, cabinet-making, work in china, glass, wood and metal, physics and industrial chemistry. In each girls' school all the different trades of women are taught.

The buildings are handsome and finely appointed, and located in the poor quarters, with the tricolor of the Republic waving over the door. Girls, to enter, must be Parisians of French parentage, thirteen years old, and able to pass an examination. The suburban communes may send a scholar by paying two hundred francs yearly. The administrators find small schools preferable, and the average is about two hundred scholars, with twenty professors.

A feature of Paris is the great number of small work-

shops interesting, and I easily saw the reason when I visited these classes. The scholars work with the flowers, buttercups, violets, or mignonettes, in a bottle of water before them, and the result is not, therefore, those remarkable productions which bloom only in the worker's fancy. The course in decoration may be confined to the lesser arts, or lead to an artist's career.

The bulk of the scholars study dressmaking. They start with a square of white muslin, and in the course of three months cover it with hemstitching. French knots, bias patches, and scallops. They next with woolen squares make pleats, ruffles, eyelets, button-holes, waist seams, and all the work connected with men's vests and women's cloaks. The miniature jackets which they make at this stage are very cunning. In their second year they cut and fit a bodice on a steel form, and with colored crinolines make miniature costumes after their own design, showing at once that taste which seems to be the national trait. Toward the last of the course they work for clients. Each school has a trying-on room, and here the girls themselves fit the customers. In their sketch-books they make pen-and-ink designs which are submitted to the teacher for permission to be carried into execution. They study water-color work, and learn to make the fashion-plates for Paris and the world.

In all these departments the school furnishes the materials, but often, when much interested, the pupils bring supplementary trimming of their own. One day of the week is often devoted to such work on their own clothes as will fit into the course. The finished work, embroidery, flowers, tapestry, which is in many cases very beautiful and valuable, is sometimes given to the scholar as a reward, but usually sold for the benefit of the school.

One branch is considered indispensable. The administrators recognize that it is likely and desirable that a girl should some day relinquish her specialty and become the head of a home. So every scholar, whatever her trade, is taught housekeeping. Each week a corps of eight go to the kitchen and work there all day with the housekeeper. Early in the morning she takes them to market to buy the luncheon with a five-franc piece, and in this way they receive such a lesson in economy and selection as I believe only a Frenchwoman can give. On their return they learn to cook and serve the meal, when it is enjoyed in a pri-

gence—in other words, the rays pass symmetrically through the prism.

That white light is made up of rays of different color and refrangibility was first proved by Sir Isaac Newton. He also showed that lights which differ in color differ also in refrangibility. By painting an oblong piece of black paper with red on one half and blue on the other, and then viewing the paper when thus colored through a prism, he found that the light reflected from the blue half was more refracted than that from the red. Placing the paper opposite a window, and looking at it through a prism with its refracting angle downward, so that the rays were bent upward, he observed that the blue was lifted higher than the red. When the angle of the prism was pointed upward the rays were deflected downward, and the blue were bent lower than the red. In both positions the light from the blue half of the paper was more refracted than that from the red.

The prismatic spectrum is now observed and investigated by means of the spectroscopic. Light is allowed to fall on a narrow slit placed at the end of a telescope tube; at the other end of the tube an achromatic lens is fixed at a distance from the slit which is equal to its focal length, so that when the light leaves the lens it consists of a bundle of parallel rays. This part of the apparatus is called a collimator. On a movable horizontal table a prism is placed, and the parallel rays from the collimator are made to fall upon it. They are thus refracted and are then observed through a telescope. The spectrum is brought to a focus by the object glass of the observing telescope, and is then viewed through the eyepiece. Both the collimator and the telescope are attached to a graduated circle, and the telescope is capable of motion round this; it can be fixed in any desired position, and this position can then be read off on verniers attached to the telescope and moving round on the graduated circle. The spreading out of a beam of light into a colored band, owing to the varying refrangibilities of the component rays, is called dispersion. As in the spectroscopic the rays leave the collimator parallel to each other, they are dispersed in the prism, and on leaving the prism there is a beam of red light with a beam of blue light at a distance from it, the red rays being parallel to each other, though inclined to the blue. The yellow and green rays come between, the rays of each color being parallel among themselves. The red rays are thus brought to a focus by the observing telescope at a definite point, and the blue rays at a neighboring but different point. Thus a pure spectrum may be obtained—that is, one in which the different colors do not overlap. The position of minimum deviation is found in this instrument by turning the prism round by moving its stand till the light is less and less deviated, and following it round with the telescope, when at length a position is reached in which, on further movement of the prism, the image of the spectrum in the telescope begins to move in the opposite direction. This is the position of minimum deviation, and any motion of the prism in either direction will increase the deviation. The telescope is now clamped in its position and the reading of the vernier on the graduated circle taken. The direct reading of the slit is taken by turning the telescope to view it when the intervening prism is removed. The difference between this last reading and the former is the angle of minimum deviation. Observations are generally made with the prism in the minimum deviation position, for this position is a readily recoverable one, and observations at different times and in different instruments can then be compared with each other.

The distance between the red end and the violet end of the spectrum is called the dispersion, and this depends on the nature of the material forming the prism. The amount of minimum deviation for a given ray depends on the index of refraction of the material of the prism.

When monochromatic light is used to illuminate the slit—for example, the yellow light given out by a spirit lamp with a salted wick, or by a Bunsen burner in which a lump of salt is heated—instead of a wide colored spectrum, a narrow image of the slit is obtained, of one color only, which would be yellow in the above instance. By observing the minimum deviation in this case, we obtain its value for certain yellow rays, and when a prism of another substance is employed, a different deviation for these same rays is got, and hence, when the angles of the prisms are known, the indices of refraction of the different substances can be compared. The refraction caused in light when it passes through a prism is due to the difference of the velocity of light through air and through the substance of the transparent medium forming the prism. If this medium consists of a block with parallel faces, and the light falls perpendicularly upon it, retardation merely ensues, the light proceeding in the same line after passing through as before, but if the light falls obliquely, it is bent in the transparent slab at an angle to its first direction, and on passing out proceeds in a line parallel with its original direction, but displaced through a certain distance, depending on the thickness and the refracting power of the slab. When the refracting substance has faces inclined at an angle, bending of the rays occurs both on entering and leaving it, and we have the phenomena observed with prisms. It is the rays which have the shortest wave length whose velocity is most altered in the prism; these are the rays of violet light. Thus violet light is most retarded—that is, it is the most refrangible, its rays being the furthest deflected from their original direction. Of the rays forming the visible spectrum, those possessing the longest wave length and forming red light are the least bent. It is pretty certain that the velocity of all the rays from the violet to the red is the same in the free ether of space. Now the velocity is equal to the product of the frequency (or the number of vibrations per second) and the wave length; therefore, these two quantities, which remain unaltered during the passage of light through space, change, one or both of them, on the passage of the light through dense matter. As the vibration in the transparent medium is excited by that in the incident light, its period is likely to be the same, so that it is probably the wave length and not the frequency which changes as the light passes through the prism. Experiment shows that the wave length of red light at one end of the visible spectrum is about twice as great as that of violet light at the

other. The range of the vibrations to which our eyes are sensitive is thus about an octave. The red waves go through nearly four hundred millions of millions of vibrations per second, while the violet vibrate about seven hundred and sixty million million times per second—that is, about twice as fast.

Solids and liquids, when raised to such a temperature that they become white hot and luminous, give as a rule a continuous spectrum—that is, one in which all the visible rays are represented, from the dark red right on through the spectrum to the extreme violet. Gases, on the other hand, when heated to incandescence and viewed through a spectroscopic, exhibit a spectrum which is made up of a few or many bright lines on a dark background. The number and position of these lines depend on the nature and condition of the gas. One of the simplest cases of gas spectra is that referred to above, obtained from the salted flame. Here the incandescent gas is the vapor of the element sodium, and at ordinary pressures, and at the temperature of the Bunsen flame, its spectrum consists of two yellow lines very close together. If the resolving power of the spectroscopic is small, these may appear as one line. By special methods of investigation, Mr. Michelson, in America, has shown that each of these yellow lines in the spectrum of sodium is made up of several very close together, but under all ordinary observation they appear as two, or one double line.

It can be readily understood why the spectrum of a gas differs from that of glowing solids, for a gas consists of molecules existing apart from each other and with a distance between, these molecules being in rapid motion and frequently coming into collision, but during the greater part of their course being free from contact with their neighbors. Not only does the motion of the gas particles consist in a movement of translation from place to place, but each has also a vibratory motion of its own, and the constituent atoms composing the molecule have also probably relative motions. It is these vibrations of the molecule which, by communication of energy to the ether, and thence to our eyes, give rise to the luminosity of the gas. Now the different varieties of molecule have modes and frequencies of vibration of their own, which they tend to assume when shaken up and disturbed by collisions with their neighbors. The only time during which they can uninterruptedly vibrate in these characteristic modes is when they are on their "free path"—that is, on their course between two collisions. In gases this time is much longer than the time during which they are in collision, while in solids or liquids the time during which a molecule is free from contact with its neighbors is so small as to be inappreciable. The molecules are practically always so disturbed by jostling with their neighbors that they give out vibrations of all sorts, and thus the rays of light from strongly heated solids consist of all possible wave lengths, and a continuous spectrum is formed.—Knowledge.

[Continued from SUPPLEMENT, No. 1026, page 16402.]

NOTES ON SOME SAPS AND SECRETIONS USED IN PHARMACY.*

By P. L. SIMMONDS, F.L.S.

KINO.—Under this common name is known as an astringent and resinous deposit, being the dried sap of several trees of India, Africa and Australia.

The best Kino, which contains about 75 per cent. of tannic acid, exudes from the sap of *Pterocarpus marsupium*, DeC., in India, and dries in angular pebble grains in the course of a day or two. Another kind which was originally brought from Africa, under the native name of Kano, is the sap of *Pterocarpus erinaceus*, Poir.

Nearly all the Australian Eucalypti exude astringent gum resins in considerable quantity, resembling Kino in appearance and property.

The red juice which flows from fissures in the barks of the Indian creepers *Butea superba* and *B. frondosa*, Roxb., yields some of the Indian Kinos. Kino is commonly used in medicine as a powerful astringent, especially in diarrhea, chronic dysentery and other such cases, and as an injection in leucorrhœa, and as an application to ulcers.

The tincture of Kino, although used medicinally, has an inconvenience, which is found to arise from its changing to the gelatinous form.

Kino resin is dearer than it has ever been within living memory, £30 per cwt. being now the nominal quotation.

The British imports are very small, only averaging 15 or 16 packages now, whereas they were 98 in 1884, and 73 in 1888.

Lactuca Species.—From several species of *Lactuca*—*L. virosa*, *L. scariola*, *L. altissima* and *L. sativa*—the drug known as "Lactucarium" is obtained. It is the hardened, milky juice which exudes from the cut stems in Germany, France and Austria. The average yield from each plant is only from 40 to 50 grains. It occurs in commerce in the form of angular pieces of a brownish color, internally opaque and wax-like. It possesses slightly narcotic properties and is useful in coughs.

Laurus Gigantea.—"Caparrapi balsam" is referred to this tree. It is so named from the village of Caparrapi, in the province of Cudinamarca, Colombia, where it is prepared. It may probably be derived from *Oreodaphne enifera*, Nees. The seed is oily and has a burning taste like capsicum. The balsam has an aromatic odor and resembles balsam of Tolu, but is more fluid.

In medicine it is used by the natives as a stimulant in catarrhal complaints, and is also employed by them in the treatment of snake bites and the stings of poisonous insects.

Liquidambar orientale, Miller; *L. imberbe*, Aiton. —A balsamic gum resin, prepared from the bark, is known as liquid Storax, and in the East as "Rose Malloes." It is stimulant and detergent and similar in action to the balsams of Peru and Tolu.

Another species, *L. styraciflua*, Lin., exudes a sweet gum through cracks in the bark and wounds in the trunk, during all seasons of the year, which hardens on exposure to the air. It is much esteemed by children for chewing and is soluble in water. This

gum yields a balsam more terebinthine in odor, but almost as pleasant as Tolu balsam. This sirup is produced in the Southern States of America. It is transparent, amber yellow, has the consistence of a thick oil, and an aromatic, bitter taste. It has been used in the form of ointment for healing indolent ulcers and for cutaneous diseases.

A sirup of Liquidambar is used for the diarrhea of infants. It is largely exported from Bombay to China, where it has for many centuries been used as a medicine. The dried and compressed residual bark, after boiling for the storax, constitutes the fragrant cakes formerly common and well known in Europe, under the name of Cortex Thymiamatis.

L. altingia, Blume, also yields the fragrant balsam known as liquid storax. It is vanilla scented, containing much styrol and styracin, and is often used for imparting scent to some sorts of tobacco and cigars, and also for keeping moths from clothing. Its use in medicine is more limited than in perfumery. The solid exudation known as storax is from the stem of *Styrax officinale*.

Moringa pterygosperma, Gaertn.—This small tree yields a gum which is white as it exudes, but gradually turns to a mahogany or claret color as it dries. This is one of the balsa Tragacanth which are used in native medicine.

Musa paradisiaca, Lin.—The sap has medicinal properties; it is used in San Domingo to stop internal and external hemorrhage, as tannin is in other countries. At the Philippines it is used to heal a species of venereal disease very common in the province of Biscayas.

Narthex asafetida, Falconer; *Ferula Narthex*, Boissier.—The *Ferula asafetida*, Linné, of Persia, Afghanistan and Turkestan, yields the ordinary medicinal gum resinous exudation locally known as Anguzi, but in India the pure drug is called "Hing," and the coarser kind "Hingra." Asafetida contains two essential oils; though the odors of oil of garlic, oil of onions and asafetida are similar, asafetida contains no trace of allyl. An exhaustive paper on this essential oil has been published by Dr. Semmler. Its density is about 0.984.

Asafetida is commonly used by the Mahometan population of India and the vegetarian Hindoo classes as a favorite ingredient in their curries, sauce for pilafs and other dishes, especially mixed with rice and dal or pulse on account of its stimulant, stomachic properties. The Turkomans are very fond of the young shoots dipped in vinegar. But it is not an article of general consumption in Afghanistan itself. The fresh leaves of the plant, which have the same peculiar odor as its secretion, when cooked, are commonly used as a diet by those near whose abode the plant grows.

The white inner part of the stem of the full grown plant is considered a delicacy when roasted and flavored with salt and butter. India seems to be the principal consumer of this gum resin, as the imports there range from eight to nine thousand hundredweight annually. Its uses in Persia are very numerous, especially as a medicine. There are people there who are so accustomed to its use for nervous complaints that it is like opium to the opium eaters—one of the necessities of life. Its excellent anti-spasmodic qualities are too little known and appreciated in Europe.

The liquid form of asafetida has, from the remotest times, been held in great estimation by Eastern doctors, and was once regarded as worth its weight in silver. It is highly esteemed as a carminative and condiment. If taken daily, it is said to prevent the attacks of malarious fever.

Among the ancients, condiments to stimulate the sluggish appetite seemed to be in chief demand. Among these asafetida, which is to-day highly relished in Persia and the East, was an indispensable ingredient; and it is even now used moderately by cooks in Europe to give flavor to some dishes and meats.

Opopanax Chironium, Koch.—This gum resinous exudation from the juice of the roots is met with in lumps and tears, is opaque, of a disagreeable balsamic odor, of a bitter acid taste. It has a slight resemblance externally to myrrh. In most of its properties it closely resembles asafetida, and is now scarcely used in medicine in Europe, although found in the bazars of India.

Papaver somniferum, Linné.—The concrete, inspissated juice from the capsules of this poppy, known as opium, is a valuable narcotic and anodyne, obtained by scratching the capsules and collecting the juice.

Great Britain imports from 400,000 to 500,000 pounds of opium annually for medicinal purposes, chiefly from Turkey and Persia. The imports into the United States since the duty has been removed, on October 2, 1890, have increased. The imports in 1890 were 473,095 pounds of crude or unmanufactured, valued at £1,183,712, and 34,465 pounds prepared for smoking, value £269,586.

In the financial year ending to 1893, the imports were, of crude, 615,957 pounds, value £1,186,824.

The chief seat for the production of opium is India, where the export trade to China used to average 126,000 cwt., valued at £10,000,000, but of late years has been falling off.

The exports were:

	Cwts.
1869	74,955
1879	125,765
1889	122,160

The exports from India in the recent financial years ending in March have been as follows:

	Quantity, Cwts.	Value.
1891-92	121,701	£9,562,260
1892-93	104,658	9,255,013
1893-94	97,910	8,019,428
1895 (11 months, to February 7)	80,865	8,617,604

The poppy is largely grown for the opium it yields in many of the provinces of China, hence the Indian exports now go to many other countries, especially Cochinchina and the Straits settlements. The export share of the two provinces has been as follows, in late years:

	Cwts. Bengal.	Cwts. Bombay.
1891-92	83,221	38,480
1892-93	70,615	34,043
1893-94	63,853	34,057

The imports of sorts of opium into China in each of the last two calendar years (January to December) have been as follows, in piculs of $1\frac{1}{4}$ cwt.:

	1892. Piculs.	1893. Piculs.
Malwa (Bombay).....	27,782	28,694
Patna.....	18,877	20,295
Benares.....	15,353	12,121
Persian.....	7,770	6,998
	70,782	68,108

The returns for 1894 are not yet to hand, but the statistical secretary of the customs at Shanghai, in his report for 1893, stated: "The protection of the rupee enhanced the price of opium so greatly that it placed the Indian drug beyond the means of a vast number of consumers, and this rise taking place concurrently with adequate supplies of native opium—which has so improved in quality that, it is averred, smokers prefer it to Malwa—renders it almost hopeless for the imported drug to continue to compete successfully with the excellent and ever-improving home-grown product."

There are two kinds of opium made in India; that for export to China is called "provision opium," that to be used locally is known as "excise opium," and is moulded into cakes, which are stamped with the device of an Imperial Crown, and the legend "Benares Akbari," from being made in that district.

Excise opium, for internal consumption, is retained to the consumer as a decoction, or in the form of two smoking mixtures, known, respectively, as Chandu and Madat. The excise opium yields to the Indian government a revenue of about £1,000,000 sterling.

The opium for export is made up into round cakes or balls, about the size of a twenty-four pound spherical shot. These are packed for shipment in chests, in two layers of 20 each, and the chests weigh about 140 pounds.

The expediency of the government production and supply of Indian opium to China has been much discussed and questioned, and a commission has been taking evidence and reported on it.

It is doubtful whether the moderate use of opium smoking is more injurious to the system than other narcotics and intoxicants, and especially when the habit has been confirmed and is almost general in China, and the culture of the poppy is allowed and fostered in many of the provinces of the empire.

The stimulant effects of opium are most apparent from small doses, which increase the energy of the mind, the frequency of the pulse, etc. These effects are succeeded by languor and lassitude. In excessive doses it proves a violent and fatal poison.

In disease it is chiefly employed to mitigate pain, produce sleep, and to check diarrhea and other excessive discharges. It is also used with good effect in intermittent and other fevers. Combined with calomel, it is employed in cases of inflammation from local causes, such as wounds, fractures, etc.; it is also employed in small-pox, dysentery, cholera, and many other complaints. It is taken in various forms in different countries.

The Chinese both smoke and swallow it. In Turkey it is chiefly taken in pills, being sometimes mixed with snuff to render it more palatable.

In England the drug is administered either in its solid state, made into pills, or as a tincture in the shape of laudanum. The natives of India take it in pills or dissolved in water. In upper India an intoxicating liquor is prepared by beating the capsules of the poppy with jaggery and water.

The native practitioners consider opium to be injurious in typhus fever, but they administer it in intermittents, lockjaw, and in certain stages of dysentery; externally, they recommend it in conjunction with arach, aloes, benzoin and bdellium, in rheumatic affections. They consider, however, after all, that it is merely efficacious in giving temporary relief.

Persian opium is cultivated principally in Yezd and Isfahan, and partly in the districts of Khorassan, Kerman, Fars and Shushes.

That grown in Yezd is considered to be better than that of Isfahan and elsewhere, owing to the climate and soil of the place being better adapted to the growth of the poppy. The crop comes to hand in May and June, and the greater part of the opium finds its way to the shipping ports between September and January. These ports are Bushire and Bunder Abbas. The Persian opium was formerly not much liked in China, owing to its having a peculiar flavor, caused by the mixture of a large quantity of oil during the process of preparation, and owing, also, to its being sometimes found adulterated. It, however, finds a better market in London, inasmuch as it contains, on an average, a larger quantity of morphia. From Yezd a quantity of opium prepared in the shape of small sticks or cylinders is sent to Herat, and a small quantity in this form is locally consumed for smoking and eating.

Opium smoking is very prevalent in Yezd, and it is said that more is used in this place in that way than in any other town in Persia, with the single exception of Kerman. The habit is gaining ground daily throughout the country.

In late years there has been a decided decrease in the crop of Persian opium. A few years ago an average crop would be reckoned at 4,000 boxes; in 1889, a fair year, it was about 3,000; in 1893 it was only about some 2,000, but for 1894 an area was planted which is calculated to give some 2,500 boxes. It was anticipated that in 1895 a very much larger quantity will be planted. The Persian merchants are looking with keen and anxious eyes to the report of the opium commission in India, and their future conduct will be greatly biased by it.

In Khorassan the cultivation of the poppy has increased tenfold within the last fifteen years. That destined for China is mixed with linseed oil, in the proportion of six to seven pounds to each chest. That sent to England is pure. Persian opium is fast overtaking Patna opium in Chinese estimation, according to the advancing prices. A very few years ago it was quoted at less than half the price of the Indian drug.

The poppy is now grown in many parts of Europe, France, Germany, etc., and is even extending to Australia and Africa. Opium raised in Europe is stated to yield from 8 to 13 per cent. of morphia. The main value of opium depends on its contents of morphia, for

which the genus *Papaver* (as far as heretofore known) remains the sole source.

Not less than fourteen alkaloids have been detected in opium by the progressive strides of organic chemistry.

The Persian opium is packed in chests containing a little over 1 cwt. The price in 1894 was £71 10s. to £72 10s. per chest. It is nearly all prepared for the China market, and there are only one or two native merchants who have sufficient knowledge to prepare the high class article required by the London market. The crop was smaller than in previous years.

The total quantity prepared in Shiraz was about 1,300 chests, of the approximate value of £93,500.

The partial destruction of the opium crops in 1893 was a heavy blow to Persian commerce. The yield for the year was very poor, and the value of the total export shows a decrease of £132,000 when compared with the export of 1892. The exports from the port of Bunder Abbas in 1892 and 1893 were as follows:

	Chests.	Value.
1892.....	746	£37,300
1893.....	743	36,578

Peucedanum Galbaniferum and *Polylophium Galbanum*.—These two plants are said to furnish the medicinal gum resinous exudation known as galbanum. It used to be referred to *Ferula galbaniflua*, Boissier, a Persian species. Galbanum may be distinguished from other gum resins by its somewhat musky odor, and by being easily indented by the finger nail, especially where the tears have a bluish tint. It is more or less brownish yellow, at ordinary temperatures tough, brittle when cold, of disagreeable smell, and acrid, nauseous, bitter taste. It is indigenous to Africa and sent to Constantinople under the name of "Khasul." The root is of a roundish form and about the size and shape of a large black radish, with two spreading shoots. The British imports are merely nominal. Galbanum is frequently used for plasters, and inwardly for menstrual illnesses in the country of its growth.

Pinus Species.—Very many species of *Pinus* yield volatile oils used in pharmacy. Among others, *P. palustris*, Ait., or *P. pinaster*, P. Tæda, *Pinus sylvestris*, Lin., *P. Pumilio*, Hank., the *P. Mugus*, Scop., and others.

Pinus Abies, Lin., *P. Picea*, Du Roi, *P. vulgaris*, *Abies excelsa*, Dec., the silver fir.—This species furnishes the oleo-resin known as Strasburg turpentine, which resembles common turpentine, but has a more agreeable odor.

P. balsamea, Lin., *Abies balsamea*, Marshall, A. balsamifera, Michx.—The balsam fir yields the well-known oleo-resin, Canada turpentine, which is exported from Quebec in kegs or large barrels. Canada balsam is used for medicinal and manufacturing purposes. It is an ingredient in blistering paper and flexible collodion. It is highly valued and much employed as a menstruum for mounting microscopic objects, and makes a fine, transparent varnish for water color drawings, which does not become darker with time.

P. Australis, Michx., *P. palustris*, Mill.—This is the most valuable of all the American pines. From it are obtained the American "turpentine," the concrete turpentine, the volatile oil from turpentine, and the resin. There are three principal descriptions of turpentine known in commerce: American, Bordeaux and Russian. Bordeaux, from *P. pinaster*, Ait.; Russian, from *P. sylvestris*, Lin.; Chian, from *Pistacia Terebinthus*, Lin.

P. Canadensis, Lin., *Abies Canadensis*, Michx., and *DeC.*—The hemlock spruce furnishes the concrete turpentine known as Canada pitch, which is official in the United States. It is slightly stimulant, like Burgundy pitch, and employed for similar purposes. A volatile oil is obtained from the leaves, which produces dangerous effects. The inner bark, being a powerful astringent, is used medicinally in America, but its chief application is for tanning. The young shoots are used in making spruce beer.

Turpentine is the general name for the oleo-resinous exudations of coniferous trees, which flows in the crude state from incisions made in the stems. The turpentines, as a rule, are yellowish-white, very viscid, transparent or translucent masses, of honey consistence and of acid reaction; of a peculiar, strong, mostly unpleasant odor, and generally of a burning, aromatic, bitter, disagreeable taste; they consist chiefly of resin and volatile oil. When distilled, this oleo-resin yields the volatile oil or "spirit of turpentine." England imports from 420,000 to 520,000 cwt. of oil of turpentine, in barrels of 2 to 3 cwt., chiefly from the Southern States. Its medicinal properties are stimulant, diuretic, occasionally diaphoretic and anhelmitic. In large doses, purgative, sometimes causing nausea, vomiting and intoxication. Previous to 1846, the tariff of Great Britain was such as to exclude imports of spirits of turpentine and resin.

Turpentine especially affects the kidneys and the mucus of the genito-urinary organs. Externally rubefacient, employed as a liniment in chronic affections. The yellow, translucent resin, the residue of the distillation of the turpentine, is important as an ingredient of plasters and ointments, which are employed as stimulant applications to indolent and ill-conditioned ulcers.

Picea vulgaris, Link., in the north of Europe, furnishes a quantity of resin, from which different products are obtained, among others, pitch. From *Larix Europæa* is obtained the resinous extract known as Briancon, or Venice turpentine, employed in consumption.

From *P. pinaster*, Ait., *P. maritima*, Poir. and Dec. (the cluster pine), galipot is obtained, also known as "Barras." It is employed, like American "turpentine," in the preparation of certain plasters. The annual production from a tree ranges from 5 to 8 pounds.

P. religiosa, H. B. K.—The turpentine produced by this tree is similar in properties to the Venice turpentine. The local name of this tree in Mexico is *Oyatmetl*.

P. sylvestris, C. Bauhin.—Tar is procured by the destructive distillation of the fir in Northern Europe and America. That used in North America is chiefly obtained from *P. palustris*, Mill. (*P. Australis*, Michx.) The tar obtained in Europe is generally considered superior to that of America. The imports of tar into the United Kingdom were, in 1892, 132,000 barrels, and

in 1893, 102,216 barrels, of about 30 gallons each. Tar acts as a stimulant, diuretic and diaphoretic, but is not much employed in medicine. It may be used internally in chronic catarrhal affections, and complaints of the urinary passages, also for some chronic skin diseases. Tar water used to be popular in England as a medicinal drink, and in France in most of the Duval and other cheap restaurants, gallons of "Eau de Goudron" are drunk daily.

A kind of barrillin is prepared from the cambium sap of this pine. An oily substance, called "fir wool spirit," has been introduced from Germany, recommended for external use in rheumatism, neuralgia, etc. *P. Larix*, Lin., *Abies Larix*, Lamarek., *Larix Europæa*, Dec.—Larch bark is considered to be stimulant, astringent and diuretic. This tree furnishes Venice turpentine, the properties and uses of which are the same as those of the other turpentines. *P. nigra*, Ait., when tapped, yields the essence of spruce, an infusion of which, with the leaves and branches, in water, sweetened with molasses, makes the chowder, or black beer, used by the fishermen of Newfoundland as an antiscorbutic.

P. Picea, Du Roi, *P. Abies*, Lin.—The resinous exudation from the spruce fir, commonly known as Burgundy pitch, is obtained chiefly in Finland and the Black Forest. It is a useful application as a plaster to the chest in chronic coughs and other pulmonary affections, to the loins in lumbago, and to the joints in rheumatism.

P. Tæda, Linn.—The oldfield, or frankincense, a fine American pine, furnishes similar products to *P. sylvestris* and *P. Australis*. It yields turpentine in good quantity, though of inferior quality, and exudes much resin.

P. Teocot, Schlecht.—The Brea turpentine produced resembles that of Bordeaux. It yields 17 per cent. of essential oil. The tree abounds in the mountains that surround the valley of Mexico, and in some other localities in that country. Its local name is *Ocotot*.

Pistacia Lentiscus, Lin.—This and *P. Atlantica* furnish the gum resin of commerce known as mastic. The largest consumption is in the east of Europe, where it is universally chewed like chicle gum in America, and thence derives its popular name. The women of Seio, Smyrna and Constantinople have almost always a piece of mastic in their mouths. It is asserted to be effectual in whitening the teeth, strengthening the gums, and sweetening the breath. Hence it is used by dentists, and also the inferior kinds for making varnishes, and is one of the ingredients in fumigation. It is obtained in the Greek Archipelago, by making incisions in the bark of the tree. When good it occurs in pale yellow, brittle, transparent drops, of an astringent taste, slightly agreeable odor, especially when heated. Such as inclines to black, green, or is dirty, should be avoided. The principal revenue of Chios, or Seio, is derived from this gum resin, of which some 4,000 to 5,000 cwt. are obtained. The picked first quality is sent to Constantinople, France and Austria, in small cases. Very little comes to England, only a few cases. The second and third qualities are used in the manufacture of mastic raki, a liqueur made with spirit, mixed with pulverized mastic, which is boiled and cooled. About 200,000 gallons of this are exported annually from Seio.

Pistacia Terebinthus, Linn.—The Chian turpentine of commerce was obtained from this tree in Seio. The produce was under 1,000 lb. a year. As a medicine it is now obsolete. It is chiefly used in Greece and other parts of the Levant, for preserving wine, and flavoring the spirituous cordial called Raki.

A resinous gum called *Alk* or *Lik* (whence the word Lac) flows so abundantly from the trees, even without incision, in Algeria, that it is often dangerous to sleep under them. It is supposed that this tree would yield good terebinthine.

The resins of Algeria are those from the teribinth cedar, juniper, *Pinus halepensis*, Mill. (of which there are large forests), *Thuya articulata*, Vahl., sandarac and mastic.

Pluchea balsamifera, Less. *Blumea balsamifera*, Dec. *Conyza balsamifera*, Lin.—This eastern shrub has diaphoretic and expectorant properties, in lung diseases. It is the source of a kind of camphor known as Ngai, exported from the Chinese port of Hoihow, in the island of Hainan, to the extent of about 15,000 lb. annually. The crude camphor is refined at Canton, and is then known as Ngai-pun, and about 10,000 lb. are exported yearly from Canton.

Plumeria phagadameia, Mart.—The milky juice is used in the Amazon valley of Brazil as a vermifuge, administered in coffee, with castor oil. It is also applied externally in rheumatism, and for the cure of ulcers, boils, dislocations, etc.

Populus balsamifera, Linn.—The leaf buds of this species, and of *P. nigra*, Lin., are gathered for medicinal purposes. Their resinous secretion is said to be diuretic and antiscorbutic. It is used to prevent rancidity in ointments, but paraffin is equally effectual.

Mimusops globosa, Gaertner, Chicle gum, exudes from this and another species in Mexico, and is largely collected, being used in the United States for chewing. The exports from Mexico in 1892 were to the value of over \$476,000.

Prosopis dulcis, H. B.—Mezquite is used in the preparation of mucilage, gum drops, jubube paste, etc. The gum, which exudes from the trunk and branches, is very soluble in water, and forms, when dissolved, a demulcent of a sweet, creamy and agreeable taste, but souring more readily, and probably containing a larger proportion of tannic and gallic acid than gum arabic.

There are vast forests of the mezquite trees, embracing millions of acres, in the southwestern part of Texas. The process of gathering the gum is simple. The outside bark of the tree is scraped off, and the gum begins to exude and form in icicle shaped masses, and, after one day's exposure in the autumn, is dry and hard enough to collect. Its color, however, unfits it for pharmaceutical purposes.

Prunus spinosa, Lin.—The acid, astringent juice of the fruit (the sloe), inspissated over a slow fire, has been used in France as a substitute for catechu. The leaves have that peculiar flavor which exists in *Spiræa ulmaria*, the American *Gaultheria*, and some other plants, which resembles the more delicate per-

fume of green tea, and hence they were said to be used as adulterants of tea. A water distilled from the blossoms is used as a medicinal vehicle in some parts of the Continent.

Pterocarpus marsupium, Roxb.—The reddish gum resin which exudes from the bark of this tree forms one of the best kinds of commerce, containing about 75 per cent. of tannic acid, and has been known in Europe for upward of a century. It is the dried sap which exudes copiously, on the stem being artificially wounded. It becomes brittle on hardening, and is very astringent. It is exported in considerable quantities from Malabar. Another kind of kino is from *Butea frondosa*. Nearly all the Australian Eucalypti exude astringent gum resins in considerable quantity, resembling kino in appearance and property. Kino is commonly used in medicine for its astringent properties, especially in diarrhea, chronic dysentery, and other such cases.

P. Santalinus, Lin.—The essential oil of sandalwood, or "sandal wood," as it is sometimes called, is prescribed for gonorrhea. This tree also yields a kind of dragon's blood.

Rhus Metopium, Lin.—This tree is known in the West Indies as the false hog gum tree. From the bark, when wounded, a transparent juice exudes, which is used on plasters as a substitute for Burgundy pitch, also in medicine as a substitute for balsam of copaiba. The milky juice of some other species of *Rhus*, especially of *R. radicans*, Lin., a variety of *R. toxicodendron*, Michx., is exceedingly poisonous.

Saccharum officinarum, Lin.—One-half of the sugar now made in the world is produced from beet root, which, however well prepared, is inferior to that obtained from the sap of the sugar cane. The latter alone is prescribed in the pharmacopoeias; it is demulcent, given in catarrhal affections, in the form of candy, sirup, etc. It is also employed in pharmacy to render oils miscible with water, and enters into the composition of several mixtures and pills, and all the confections, sirups, and lozenges.

Molasses is the drainage from raw or muscovado sugar. It is sometimes sold as "golden sirup." Treacle, which is darker and thicker, is that which drains from refined sugar in the moulds. Treacle is slightly laxative, and is used in pharmacy to give cohesiveness to pill masses. To persons disposed to dyspepsia and bilious habits, sugar in excess becomes more hurtful than otherwise. Sugar, when concentrated, is highly antiseptic, and, from a knowledge of its possessing this principle, it is frequently employed in the preservation of vegetable, animal, and medicinal substances. In cases of poisoning by copper, arsenic, or corrosive sublimate, sugar has been successfully employed as an antidote; and white sugar finely pulverized is occasionally sprinkled upon ulcers with unhealthy granulations.

Salix tetrasperma, Roxb.—At the commencement of the hot season in India, the upper surface of the leaves of this tree are occasionally covered with a sugary exudation, which dries up in thin white flakes to a sugar or manna. The same trees often yield this exudation several years in succession, but it appears to be confined to a few trees and is not common. Two or three other species of *Salix* have also been observed to yield a saccharine exudation—*S. fragilis*, in Persia; *S. Chilensis*, in Chile, and a species in the Punjab.

Syrax benzoin, Dryand.; *Benzoin officinalis*, Hayne; *Lithocarpus Benzoin*, Blume.—Benzoin, known in commerce as "Gum Benjamin," is an odoriferous or balsamic gum resin, an exudation from the stem of trees in Siam and Sumatra, and imported in small chests of 2½ cwt. These two qualities are chiefly used in medicine; the one in tears from Siam and the other in agglutinated masses from the far East. The former is the purest and has the strongest odor. Its medicinal properties are stimulant, expectorant, and styptic. It is used also in perfumery, for incense, and in making aromatic pastilles, coating court plaster, and for healing wounds.

The imports into London were, in 1891: 3,464 chests; 1892, 2,655 chests; and in 1893, 3,163 chests. Benzoin was formerly employed in chronic bronchitis and dysentery, but is now chiefly used in the tincture known as "friar's balsam," as a styptic and stimulant to wounds and old ulcers. Benzoic acid is stimulant and diuretic, and also a valuable antiseptic.

Tabashur, a word of Sanskrit origin, Tavakshiri meaning cow's milk.—This secretion is procured from the joints, or Internodes, of the female bamboo, *Bambusa arundinacea*, W. It so far resembles siliceous salt, as to form a kind of glass when fused with alkalis. It is also unaffected by fire and acids. It is called "bamboo salt," and is employed medicinally in the East as a tonic and astringent in the cure of all sorts of paralytic complaints, flatulences and poisons. This hydrate of alumina is often found in the soil where a plantation of bamboos has been burnt. P. Smith gives the following analysis of its composition:

Silica.....	90.50
Potash.....	1.10
Peroxide of iron.....	0.90
Alumina.....	0.40
Water.....	4.87
Sap.....	3.33
	100.00

Beesha Rhudii, Kunth. (*Melocanna bambusoides*, Tim.), yields more or less of the Tabashur; sometimes, it is said, the cavity is nearly filled with this siliceous crystallization.

Toluifera balsamum, Lin.; *Myroxylon Toluifera*, H. B. K.; *Myrospermum toluiferum*, A. Reeh.—There are many other synonyms of this tree.

There is great confusion yet as to the origin of the two balsams, Peru and Tolu. The exudation known as "balsam of Tolu" is obtained by incisions in the trunk. When in the first state it is thickish, yellow, becomes slowly darker and solid, and has a very pleasant odor and an agreeable taste. It is chiefly obtained in New Granada, and exudes only from the tree during the heat of the day. The tree inhabits the mountains and banks of the River Magdalena. The balsam, which contains cinnamic acid, is used as a stimulant expectorant, and for favoring by confectioners and perfumers. It is largely imported into the United States, the imports averaging 42,000 pounds in the three years ending 1890. In the form of lozenges it is a pop-

ular and agreeable remedy for appeasing troublesome coughs, and gives a pleasant odor to lip salve.

Toluifera Pereira (Roxb.) Baillon; *Myroxylon periferum*, Lin. fl.; *Myrospermum Salvatoriense*.—This balsam tree, like Tolu, has received many synonyms from different authors. The balsam is a beautiful tree, averaging 100 feet in height and 20 inches in diameter. It grows almost exclusively on the coast of Salvador, comprised by the southern shores of the departments of Sonsonate and Libertad. It is known locally as quit.quino, or white balsam, when first obtained, but this name is also given to a balsam from the pressed fruit. It is a transparent deep reddish brown or black liquid, similar in color and consistence to dark molasses, smells vanilla-like, but somewhat empyreumatic, tastes a little bitter, sharp, and burning.

There are two methods of extracting the liquid. The first consists in scraping the skin of the bark to the depth of one-tenth of an inch with a sharp machete in small spaces some twelve to fifteen inches square, all along the trunk and stout branches of the trees. Immediately after this operation, the portions scraped are heated with burning torches made out of the dried branches of a tree, and after this pieces of old cotton cloth are spread on the warmed and half-charred bark. By punching the edges of the cloth against the tree with the point of the machete, they are made to adhere. In this condition they are left for twenty-four and even forty-eight hours, when the rags are gathered and submitted to a decoction in large iron pots. After this the rags are subjected, while still hot, to great pressure in an Indian machine made of strong ropes and wooden levers worked by hand. The balsam oozes out and falls into a receptacle, where it is allowed to cool. This is called raw balsam. To refine it they boil it again and drain it, after which they pack it in iron cans ready for market. The other method of extracting balsam consists in entirely barking the trunk and heavy branches of the tree, a process which, as a rule, kills it outright, and at best renders it useless for several years. The bark is finely ground, boiled and submitted to pressure in order to extract the oil, which is considered of an inferior quality to that obtained by the system first described. Both methods are defective, but the latter is ruinous, and is forbidden by the authorities. The name of "Peruvian balsam" was given to this article because it was first sent from Salvador to Peru, in the time of the Spaniards, and from Callao reshipped to England.

About 6,000 pounds of the balsam go to the United States annually. Thirty years ago, many thousand pounds of it were received in England, but the imports there rarely exceed now 2,000 pounds. It is a warm and stimulating tonic and expectorant, useful in chronic catarrh, asthma, and other pectoral complaints and rheumatism. Externally it is much used in Europe, in the treatment of scabies, as being equally effective, and more agreeable than sulphur in its application.

The balsams of Tolu and Peru are employed occasionally medicinally in the state of sirup or tincture, particularly in cough mixtures; their fragrance also renders them pleasant adjuncts to chocolate, liqueurs, and other articles.

Balsam of Peru is seldom met with in commerce adulterated. The best test is its specific gravity, which ought to be between 1.14 and 1.16. The difficulty of taking the specific gravity is best overcome by making a solution of one part of chloride of sodium in five parts of water, the specific gravity of which is 1.125. In this liquor a drop of Peru balsam, if pure, ought to sink down. (Other tests were given in Vol. 66, p. 100.)

Uncaria Gambir, Roxb.; *Nauclaea Gambir*, Hunter.—This plant yields the extract known as pale catechu in pharmacy, which is largely imported into Europe from Singapore, under the commercial name of Gambier, and frequently under the old erroneous designation of "Terra japonica." It is, like catechu, a powerful astringent, used chiefly in diarrhea. Lozenges are said to be the best medium of administering it in relaxed condition of the throat, uvula and tonsils, in sponginess of the gums, salivation, etc. They may be employed in pyrosis and other cases in which astringents are indicated. This extract contains only about half the astringent matter of that obtained from the trunk of *Acacia Catechu*. (Tests to determine the two are given, Vol. 66, p. 103.)

The exports from Singapore average over 40,000 tons, of which more than half comes to England, to be chiefly used by tanners and dyers, and about 13,000 tons to the United States.

Unona Narum, Dun.; *Uvaria Narum*, Bl.; *U. Zeylanica*, Lam.—A greenish, sweet-smelling oil, is obtained in Malabar by distilling the roots of this evergreen climber, which is used medicinally as a stimulant in rheumatism. The seeds are carminative.

Vateria indica, Lin.; *Elaeocarpus copallinus*, Retz.—The resin from this tree is the white dammar, or ludian copal, known also as "piney varnish." Under the influence of gentle heat, it combines with wax and oil, and forms an excellent resinous ointment.

Xanthorrhoea Tatei, Mueller.—This, one of the largest of the so-called "Australian grape trees," furnishes the "black boy gum," a balsamic resin of a bright yellow color and pleasant fragrant odor, when burned as incense. It is used for the manufacture of sealing wax, and picric acid (which it yields in large percentages), and for varnishes. It is also known as "gum acroides." It tastes slightly astringent and aromatic, like storax or benzoin, containing benzoic and cinnamic acids. This resin is also commercially obtained from *X. resinosa*, Persoon; *X. quadrangulata*, Mueller, of South Australia; *X. Preissii*, Endlicher, of West Australia, and *X. hastilis*, and *X. Australis*, R. Brown, of New South Wales.

A NEW METHOD OF ARTIFICIAL RESPIRATION.

THE Gazette médicale de Paris for August 10 contains an abstract of an article on a method of inducing respiration, by Dr. Berthold Beer, which appeared in the Wiener medicinische Blätter. The method consists in the employment of ice as follows: The mucous membrane of the lips and of the mouth is rubbed slowly with a piece of ice, the rhythm of the motion corre-

sponding as much as possible to that of normal respiration. In the cases observed by Dr. Beer the result was a return of respiration, very strong at first, but, with the continued application of the ice, becoming very regular, quiet and deep. The ice used in this way is said to have, moreover, a general sedative effect, and the author has employed this quieting action with success in the treatment of cerebral troubles. Dr. Foges, of Vienna, has obtained equally favorable results with this treatment in two cases of asphyxia. In all cases it is a method that may be employed for several hours at a time, as it is harmless for the patient and easy for the physician. It also offers other advantages owing to its sedative action.

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